UNION TAPER SHANK TWIST DRILLS

CARBON STEEL, No. 100 **HIGH SPEED STEEL, No. 500**

Fig. 5177A

EFFECTIVE JULY 1, 1917

Diameter Inches	Length Over All Inches	Twist Cut Inches	Price, Each		Diameter Inches	Length Over All Inches	Twist Cut Inches	Price, Each		Diameter Inches	Length Over All Inches	Twist Cut Inches	Price, Each	
			Carbon Steel	High Speed Steel				Carbon Steel	High Speed Steel				Carbon Steel	High Speed Steel
1/16	4 7/16	1 1/4	.45	.90	9/16	8 1/4	4 7/8	1.40	2.25	1 1/16	11 1/4	6 5/8	4.00	7.25
5/64	4 9/16	1 3/8	.45	.90	37/64	8 1/2	4 5/8	1.50	2.40	1 5/64	11 1/2	6 7/8	4.25	7.75
3/32	4 9/16	1 1/2	.45	.90	19/32	8 1/2	4 5/8	1.50	2.40	1 3/32	11 1/2	6 7/8	4.25	7.75
7/64	4 11/16	1 11/16	.45	.90	39/64	8 3/4	4 7/8	1.60	2.50	1 7/64	11 3/4	7 1/8	4.50	8.25
1/8	5 3/16	2 3/16	.45	.90	5/8	8 3/4	4 7/8	1.60	2.50	1 1/8	11 3/4	7 1/8	4.50	8.25
9/64	5 5/16	2 5/16	.45	.90	41/64	9	5 1/8	1.70	2.75	1 9/64	11 7/8	7 1/4	4.75	8.90
5/32	5 7/16	2 7/16	.45	.90	21/32	9	5 1/8	1.70	2.75	1 5/32	11 7/8	7 1/4	4.75	8.90
11/64	5 9/16	2 9/16	.50	.90	43/64	9 1/4	5 3/8	1.80	3.00	1 11/64	12	7 3/8	5.00	9.50
3/16	5 5/16	2 5/16	.50	.90	11/16	9 1/4	5 3/8	1.80	3.00	1 3/16	12	7 3/8	5.00	9.50
13/64	5 15/16	2 7/8	.55	1.00	45/64	9 1/2	5 5/8	1.90	3.25	1 13/64	12 1/8	7 1/2	5.25	10.15
7/32	6 1/16	2 1/16	.55	1.00	23/32	9 1/2	5 5/8	1.90	3.25	1 7/32	12 1/8	7 1/2	5.25	10.15
15/64	6 3/16	2 3/16	.60	1.10	47/64	9 3/4	5 7/8	2.00	3.50	1 15/64	12 1/2	7 7/8	5.50	10.75
1/4	6 3/16	2 3/16	.60	1.10	3/4	9 3/4	5 7/8	2.00	3.50	1 1/4	12 1/2	7 7/8	5.50	10.75
17/64	6 1/4	2 7/8	.65	1.20	49/64	9 7/8	6	2.10	3.75	1 17/64	14 1/8	8 1/2	5.75	11.50
9/32	6 1/4	2 7/8	.65	1.20	25/32	9 7/8	6	2.10	3.75	1 9/32	14 1/8	8 1/2	5.75	11.50
19/64	6 3/8	3	.70	1.30	51/64	10	6 1/8	2.20	4.00	1 19/64	14 1/4	8 5/8	6.00	12.25
5/16	6 3/8	3	.70	1.30	13/16	10	6 1/8	2.20	4.00	1 5/16	14 1/4	8 5/8	6.00	12.25
21/64	6 1/2	3 1/8	.75	1.40	53/64	10 1/4	6 3/8	2.40	4.40	1 21/64	14 3/8	8 3/4	6.25	13.00
11/32	6 1/2	3 1/8	.75	1.40	27/32	10 1/4	6 3/8	2.40	4.40	1 11/32	14 3/8	8 3/4	6.25	13.00
23/64	6 3/4	3 3/8	.80	1.50	55/64	10 1/2	6 5/8	2.60	4.75	1 23/64	14 1/2	8 7/8	6.50	13.75
3/8	6 3/4	3 3/8	.80	1.50	7/8	10 1/2	6 5/8	2.60	4.75	1 3/8	14 1/2	8 7/8	6.50	13.75
25/64	7	3 5/8	.90	1.65	57/64	10 5/8	6 3/4	2.80	5.15	1 25/64	14 5/8	9	7.00	14.65
13/32	7	3 5/8	.90	1.65	29/32	10 5/8	6 3/4	2.80	5.15	1 13/32	14 5/8	9	7.00	14.65
27/64	7 1/4	3 7/8	1.00	1.75	59/64	10 3/4	6 7/8	3.00	5.50	1 27/64	14 3/4	9 1/8	7.50	15.50
7/16	7 1/4	3 7/8	1.00	1.75	15/16	10 3/4	6 7/8	3.00	5.50	1 7/16	14 3/4	9 1/8	7.50	15.50
29/64	7 1/2	4 1/8	1.10	1.90	61/64	10 7/8	6 1/4	3.25	5.90	1 29/64	14 7/8	9 1/4	8.00	16.40
15/32	7 1/2	4 1/8	1.10	1.90	31/32	10 7/8	6 1/4	3.25	5.90	1 15/32	14 7/8	9 1/4	8.00	16.40
31/64	7 3/4	4 3/8	1.20	2.00	63/64	11	6 3/8	3.50	6.25	1 31/64	15	9 3/8	8.50	17.25
1/2	7 3/4	4 3/8	1.20	2.00	1	11	6 3/8	3.50	6.25	1 1/2	15	9 3/8	8.50	17.25
33/64	8	4 5/8	1.30	2.15	1 1/64	11 1/8	6 1/2	3.75	6.75	1 33/64	15	9 3/8	9.00	18.15
17/32	8	4 5/8	1.30	2.15	1 1/32	11 1/8	6 1/2	3.75	6.75	1 17/32	15	9 3/8	9.00	18.15
35/64	8 1/4	4 7/8	1.40	2.25	1 3/64	11 1/4	6 5/8	4.00	7.25	1 35/64	15 1/4	9 5/8	9.50	19.00

ABOVE DRILLS HAVE TAPER SHANKS AS FOLLOWS

Diameters (inclusive) ..... inches	1/16 to 9/16	37/64 to 29/32	59/64 to 1 1/4	1 17/64 to 1 35/64
Morse Taper Shank ..... number	1	2	3	4

UNION TAPER SHANK TWIST DRILLS

CARBON STEEL, No. 100 HIGH SPEED STEEL, No. 500

Fig. 15454A

EFFECTIVE JULY 1, 1917

Diameter Inches	Length Over All Inches	Twist Cut Inches	Price, Each		Diameter Inches	Length Over All Inches	Twist Cut Inches	Price, Each		Diameter Inches	Length Over All Inches	Twist Cut Inches	Price, Each	
			Carbon Steel	High Speed Steel				Carbon Steel	High Speed Steel				Carbon Steel	High Speed Steel
1 9/16	15 1/4	9 5/8	9.50	19.00	2 3/64	17	10	20.00	37.50	2 17/32	19 1/4	11 5/8	31.25	67.50
1 37/64	15 1/4	9 5/8	10.00	20.00	2 1/16	17	10	20.00	37.50	2 35/64	19 1/4	11 5/8	32.00	70.00
1 19/32	15 1/4	9 5/8	10.00	20.00	2 5/64	17	10	20.75	38.75	2 9/16	19 1/4	11 5/8	32.00	70.00
1 39/64	15 1/2	9 7/8	10.50	21.00	2 3/32	17	10	20.75	38.75	2 37/64	19 1/2	11 7/8	33.00	72.50
1 5/8	15 1/2	9 7/8	10.50	21.00	2 7/64	17	10	21.50	40.00	2 19/32	19 1/2	11 7/8	33.00	72.50
1 41/64	15 1/2	9 7/8	11.00	22.00	2 1/8	17	10	21.50	40.00	2 39/64	19 1/2	11 7/8	34.00	75.00
1 21/32	15 1/2	9 7/8	11.00	22.00	2 9/64	17	10	22.25	41.25	2 5/8	19 1/2	11 7/8	34.00	75.00
1 43/64	15 3/4	10 1/8	11.50	23.00	2 5/32	17	10	22.25	41.25	2 41/64	20	12 1/4	35.00	77.50
1 11/16	15 3/4	10 1/8	11.50	23.00	2 11/64	17	10	23.00	42.50	2 21/32	20	12 1/4	35.00	77.50
1 45/64	15 3/4	10 1/8	12.00	24.00	2 3/16	17	10	23.00	42.50	2 43/64	20	12 1/4	36.00	80.00
1 23/32	15 3/4	9 11/16	12.00	24.00	2 13/64	17 1/2	10 1/2	23.75	43.75	2 11/16	20	12 1/4	36.00	80.00
1 47/64	16	9 15/16	12.50	25.00	2 7/32	17 1/2	10 1/2	23.75	43.75	2 45/64	20 1/2	12 3/4	37.00	82.50
1 3/4	16	9 15/16	12.50	25.00	2 15/64	17 1/2	10 1/2	24.50	45.00	2 23/32	20 1/2	12 3/4	37.00	82.50
1 49/64	16	9 15/16	13.25	26.25	2 1/4	17 1/2	10 1/8	24.50	45.00	2 47/64	20 1/2	12 3/4	38.00	85.00
1 25/32	16	9 15/16	13.25	26.25	2 17/64	17 1/2	10 1/8	25.25	47.50	2 3/4	20 1/2	12 5/8	38.00	85.00
1 51/64	16 1/4	10 3/16	14.00	27.50	2 9/32	17 1/2	10 1/8	25.25	47.50	2 49/64	20 1/2	12 5/8	39.25	87.50
1 13/16	16 1/4	10 1/8	14.00	27.50	2 19/64	17 1/2	10 1/8	26.00	50.00	2 25/32	20 1/2	12 5/8	39.25	87.50
1 53/64	16 1/4	10 1/8	14.75	28.75	2 5/16	17 1/2	10 1/8	26.00	50.00	2 51/64	20 1/2	12 5/8	40.50	90.00
1 27/32	16 1/4	10 1/8	14.75	28.75	2 21/64	18	10 5/8	26.75	52.50	2 13/16	20 1/2	12 5/8	40.50	90.00
1 55/64	16 1/2	10 3/8	15.50	30.00	2 11/32	18	10 5/8	26.75	52.50	2 53/64	21	13 1/8	41.75	92.50
1 7/8	16 1/2	10 3/8	15.50	30.00	2 23/64	18	10 5/8	27.50	55.00	2 27/32	21	13 1/8	41.75	92.50
1 57/64	16 1/2	10 3/8	16.25	31.25	2 3/8	18	10 1/2	27.50	55.00	2 55/64	21	13 1/8	43.00	95.00
1 29/32	16 1/2	10 3/8	16.25	31.25	2 25/64	18 1/2	11	28.25	57.50	2 7/8	21	13	43.00	95.00
1 59/64	16 1/2	10 3/8	17.00	32.50	2 13/32	18 1/2	11	28.25	57.50	2 57/64	21	13	44.25	97.50
1 15/16	16 1/2	10 1/4	17.00	32.50	2 27/64	18 1/2	11	29.00	60.00	2 29/32	21	13	44.25	97.50
1 61/64	16 1/2	10 1/4	17.75	33.75	2 7/16	18 1/2	11	29.00	60.00	2 59/64	21	13	45.50	100.00
1 31/32	16 1/2	10 1/4	17.75	33.75	2 29/64	19	11 1/2	29.75	62.50	2 15/16	21	13	45.50	100.00
1 63/64	16 1/2	10 1/4	18.50	35.00	2 15/32	19	11 1/2	29.75	62.50	2 61/64	22	14	46.75	102.50
2	16 1/2	10 1/4	18.50	35.00	2 31/64	19	11 1/2	30.50	65.00	2 31/32	22	14	46.75	102.50
2 1/64	16 1/2	9 1/2	19.25	36.25	2 1/2	19	11 3/8	30.50	65.00	2 63/64	22	14	48.00	105.00
2 1/32	16 1/2	9 1/2	19.25	36.25	2 33/64	19 1/4	11 5/8	31.25	67.50	3	22	13 7/8	48.00	105.00

ABOVE DRILLS HAVE TAPER SHANKS AS FOLLOWS

Diameters (inclusive) ..... inches	1 9/16 to 2	2 1/64 to 3
Morse Taper Shank ..... number	4	5

UNION STRAIGHT SHANK TWIST DRILLS

JOBBERS' LENGTH

CARBON STEEL, No. 115 — HIGH SPEED STEEL, No. 515

Fig. 15431A

EFFECTIVE JULY 1, 1917

Diam. Inches	Length Over All Inches	Twist Cut Inches	Decimal Equivalent	Price, per Dozen Carbon Steel	Price, per Dozen High Speed Steel	Diam. Inches	Length Over All Inches	Twist Cut Inches	Decimal Equivalent	Price, per Dozen Carbon Steel	Price, per Dozen High Speed Steel
1/32	1 1/16	9/16	.0312	1.50	....	9/32	4 1/4	2 31/32	.2812	3.80	9.10
3/64	1 11/16	25/32	.0468	1.55	....	19/64	4 3/8	3 3/32	.29687	4.00	10.50
1/16	2 1/2	1 1/4	.0625	1.60	5.70	5/16	4 1/2	3 3/16	.3125	4.35	10.50
5/64	2 5/8	1 3/8	.0781	1.65	5.70	21/64	4 5/8	3 5/16	.3281	4.70	12.00
3/32	2 3/4	1 1/2	.0937	1.70	5.70	11/32	4 3/4	3 13/32	.3437	5.05	12.00
7/64	2 7/8	1 11/16	.1093	1.75	5.90	23/64	4 7/8	3 17/32	.3593	5.50	13.50
1/8	3	1 13/16	.125	1.80	5.90	3/8	5	3 5/8	.375	6.00	13.50
9/64	3 1/8	1 15/16	.1406	1.85	6.10	25/64	5 1/8	3 3/4	.3906	6.50	15.00
5/32	3 1/4	2 3/32	.1562	1.90	6.10	13/32	5 1/4	3 27/32	.4062	7.00	15.00
11/64	3 3/8	2 7/32	.1718	2.00	6.30	27/64	5 3/8	3 31/32	.4218	7.75	17.00
3/16	3 1/2	2 5/16	.1875	2.25	6.30	7/16	5 1/2	4 1/16	.4375	8.50	17.00
13/64	3 5/8	2 7/16	.2031	2.50	7.00	29/64	5 5/8	4 3/16	.4531	9.25	18.75
7/32	3 3/4	2 17/32	.2187	2.75	7.00	15/32	5 3/4	4 9/32	.4687	10.00	18.75
15/64	3 7/8	2 21/32	.2343	3.00	7.35	31/64	5 7/8	4 13/32	.4843	11.00	20.00
1/4	4	2 3/4	.25	3.25	7.35	1/2	6	4 1/2	.5	12.00	20.00
17/64	4 1/8	2 7/8	.2656	3.50	9.10	..	...	...	.....	....	.....

LETTER SIZES

CARBON STEEL, No. 120

Gauge	Length Over All Inches	Twist Cut Inches	Decimal Equivalent	Price, per Dozen Carbon Steel	Price, per Dozen High Speed Steel
A	3 13/16	2 19/32	.234	3.00	7.35
B	3 13/16	2 19/32	.238	3.05	7.35
C	3 13/16	2 19/32	.242	3.10	7.35
D	3 13/16	2 19/32	.246	3.15	7.35
E	3 13/16	2 9/16	.250	3.25	7.35
F	4 1/4	3	.257	3.35	9.10
G	4 1/4	3	.261	3.45	9.10
H	4 1/4	3	.266	3.55	9.10
I	4 1/4	3	.272	3.65	9.10
J	4 1/4	3	.277	3.70	9.10
K	4 1/4	3	.281	3.80	9.10
L	4 1/4	2 31/32	.290	3.90	10.50
M	4 1/4	2 31/32	.295	4.00	10.50

HIGH SPEED STEEL, No. 520

Gauge	Length Over All Inches	Twist Cut Inches	Decimal Equivalent	Price, per Dozen Carbon Steel	Price, per Dozen High Speed Steel
N	4 1/4	2 31/32	.302	4.25	10.50
O	4 1/4	2 15/16	.316	4.40	10.50
P	4 5/8	3 5/16	.323	4.60	12.00
Q	4 5/8	3 5/16	.332	4.75	12.00
R	4 3/4	3 7/16	.339	5.00	12.00
S	4 3/4	3 7/16	.348	5.15	13.50
T	4 7/8	3 17/32	.358	5.30	13.50
U	4 7/8	3 17/32	.368	5.50	13.50
V	5	3 5/8	.377	6.00	13.50
W	5 1/8	3 3/4	.386	6.50	15.00
X	5 1/8	3 3/4	.397	6.75	15.00
Y	5 1/4	3 7/8	.404	7.00	15.00
Z	5 3/8	3 31/32	.413	7.25	17.00

UNION STRAIGHT SHANK WIRE TWIST DRILLS

Fig. 4238A

EFFECTIVE JULY 1, 1917

Number by Gauge	Approximate Length Inches	Twist Cut Inches	Decimals of Inch	Price Carbon Steel per Dozen	Price High Speed Steel per Dozen	Number by Gauge	Approximate Length Inches	Twist Cut Inches	Decimals of Inch	Price Carbon Steel per Dozen	Price High Speed Steel per Dozen
1	4	2 21/32	.2280	2.75	7.00	41	2 5/16	1 5/16	.096	1.70	5.70
2	3 15/16	2 5/8	.2210	2.75	7.00	42	2 5/16	1 1/4	.0935	1.70	5.70
3	3 15/16	2 5/8	.2130	2.75	7.00	43	2 1/4	1 7/32	.089	1.70	5.70
4	3 7/8	2 19/32	.2090	2.75	7.00	44	2 3/16	1 3/16	.086	1.70	5.70
5	3 13/16	2 9/16	.2055	2.75	7.00	45	2 3/16	1 1/8	.082	1.70	5.70
6	3 13/16	2 17/32	.2040	2.50	7.00	46	2 1/8	1 1/8	.081	1.65	5.70
7	3 3/4	2 1/2	.2010	2.50	7.00	47	2 1/16	1 3/32	.0785	1.65	5.70
8	3 11/16	2 15/32	.1990	2.50	7.00	48	2 1/16	1 1/16	.076	1.65	5.70
9	3 11/16	2 7/16	.1960	2.50	7.00	49	2	1	.073	1.65	5.70
10	3 5/8	2 3/8	.1935	2.50	7.00	50	1 15/16	31/32	.07	1.65	5.70
11	3 9/16	2 11/32	.1910	2.25	6.30	51	1 15/16	15/16	.067	1.60	5.70
12	3 9/16	2 5/16	.1890	2.25	6.30	52	1 7/8	7/8	.0635	1.60	5.70
13	3 1/2	2 9/32	.1850	2.25	6.30	53	1 13/16	27/32	.0595	1.60	....
14	3 7/16	2 1/4	.1820	2.25	6.30	54	1 13/16	27/32	.055	1.60	....
15	3 7/16	2 7/32	.1800	2.25	6.30	55	1 3/4	13/16	.052	1.60	....
16	3 3/8	2 3/16	.1770	2.00	6.30	56	1 11/16	25/32	.0465	1.55	....
17	3 5/16	2 5/32	.1730	2.00	6.30	57	1 11/16	23/32	.043	1.55	....
18	3 5/16	2 1/8	.1695	2.00	6.30	58	1 5/8	23/32	.042	1.55	....
19	3 1/4	2 3/32	.1660	2.00	6.30	59	1 9/16	11/16	.041	1.55	....
20	3 3/16	2 1/16	.1610	2.00	6.30	60	1 9/16	11/16	.04	1.55	....
21	3 3/16	2 1/16	.1590	1.90	6.10	61	1 1/2	5/8	.039	1.50	....
22	3 1/8	2	.1570	1.90	6.10	62	1 1/2	5/8	.038	1.50	....
23	3 1/16	1 31/32	.1540	1.90	6.10	63	1 1/2	5/8	.037	1.50	....
24	3 1/16	1 15/16	.1520	1.90	6.10	64	1 1/2	5/8	.036	1.50	....
25	3	1 29/32	.1495	1.90	6.10	65	1 1/2	5/8	.035	1.50	....
26	2 15/16	1 7/8	.1470	1.80	6.10	66	1 1/2	9/16	.033	1.50	....
27	2 15/16	1 27/32	.1440	1.80	6.10	67	1 7/16	9/16	.032	1.50	....
28	2 7/8	1 13/16	.1405	1.80	6.10	68	1 7/16	9/16	.031	1.50	....
29	2 13/16	1 3/4	.1360	1.80	6.10	69	1 3/8	9/16	.02925	1.50	....
30	2 13/16	1 23/32	.1285	1.80	6.10	70	1 5/16	9/16	.028	1.50	....
31	2 3/4	1 11/16	.1200	1.75	5.90	71	1 5/16	1/2	.026	1.50	....
32	2 11/16	1 5/8	.1160	1.75	5.90	72	1 1/4	7/16	.025	1.50	....
33	2 11/16	1 5/8	.1130	1.75	5.90	73	1 3/16	3/8	.024	1.50	....
34	2 5/8	1 9/16	.1110	1.75	5.90	74	1 1/8	5/16	.0225	1.50	....
35	2 9/16	1 1/2	.1100	1.75	5.90	75	1 1/16	1/4	.021	1.50	....
36	2 9/16	1 1/2	.1065	1.75	5.90	76	1	1/4	.02	1.50	....
37	2 1/2	1 7/16	.1040	1.75	5.90	77	15/16	7/32	.018	1.50	....
38	2 7/16	1 3/8	.1015	1.75	5.90	78	7/8	7/32	.016	1.50	....
39	2 7/16	1 11/32	.0995	1.75	5.90	79	13/16	3/16	.0145	1.50	....
40	2 3/8	1 11/32	.0980	1.75	5.90	80	3/4	3/16	.0135	1.50	....

UNION TAPER SQUARE SHANK TWIST DRILLS

No. 1 — **FITTING RATCHETS** — **No. 2**

CARBON STEEL, No. 135
HIGH SPEED STEEL, No. 535

CARBON STEEL, No. 140
HIGH SPEED STEEL, No. 540

Fig. 15484A

No. 1 OR SMALL SHANK
3/8x5/8x1 1/2 INCHES

Diam. Inches	Length Over All Inches	Twist Cut Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
1/8	4 3/16	1 13/16	.90	....
5/32	4 7/16	2 3/32	.95	....
3/16	4 11/16	2 5/16	.95	....
7/32	4 13/16	2 17/32	1.00	....
1/4	5	2 9/16	1.00	2.50
9/32	5	2 9/16	1.05	2.55
5/16	5	2 9/16	1.10	2.60
11/32	5	2 3/4	1.15	2.65
3/8	6	3 3/4	1.20	2.70
13/32	6 1/4	4	1.25	2.75
7/16	6 1/4	4	1.25	2.80
15/32	6 1/4	4	1.30	2.85
1/2	6 1/2	4 1/4	1.30	2.90
17/32	6 1/2	4 1/4	1.35	2.95
9/16	6 1/2	4 1/4	1.35	3.00
19/32	6 1/2	4 1/4	1.40	3.10
5/8	6 1/2	4 1/4	1.40	3.20
21/32	6 1/2	4 3/16	1.45	3.30
11/16	6 1/2	4 3/16	1.45	3.40
23/32	6 1/2	4 3/16	1.50	3.50
3/4	6 1/2	4 3/16	1.55	3.65
25/32	6 3/4	4 7/16	1.65	3.80
13/16	7	4 11/16	1.75	4.00
27/32	7 1/4	4 15/16	1.90	4.20
7/8	7 1/2	5 3/16	2.05	4.50
29/32	7 3/4	5 7/16	2.20	4.70
15/16	8	5 11/16	2.30	5.00
31/32	8 1/4	5 15/16	2.40	5.25
1	8 1/2	6 3/16	2.55	5.50
1 1/32	8 3/4	6 7/16	2.70	5.75
1 1/16	9	6 11/16	2.85	6.00
1 3/32	9	6 11/16	3.00	6.30
1 1/8	9	6 11/16	3.10	6.70
1 5/32	9	6 11/16	3.25	7.00
1 3/16	9	6 11/16	3.35	7.30
1 7/32	9	6 11/16	3.50	7.60
1 1/4	9	6 11/16	3.65	7.90
1 9/32	9	6 11/16	3.75	8.25
1 5/16	9	6 11/16	3.90	8.60
1 11/32	9	6 11/16	4.05	9.00
1 3/8	9	6 11/16	4.20	9.40
1 13/32	9	6 11/16	4.35	9.80
1 7/16	9	6 11/16	4.50	10.20
1 15/32	9	6 11/16	4.65	10.60
1 1/2	9	6 11/16	4.80	11.00

No. 2 OR LARGE SHANK
1/2x3/8x1 3/8 INCHES

Diam. Inches	Length Over All Inches	Twist Cut Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
1/8	4 7/16	1 13/16	.90	....
5/32	4 11/16	2 3/32	.95	....
3/16	4 15/16	2 5/16	.95	....
7/32	5 1/16	2 17/32	1.00	....
1/4	5	2 9/16	1.00	2.50
9/32	5	2 5/16	1.05	2.55
5/16	5	2 5/16	1.10	2.60
11/32	5	2 1/2	1.15	2.65
3/8	6	3 1/2	1.20	2.70
13/32	6 1/4	3 3/4	1.25	2.75
7/16	6 1/4	3 3/4	1.25	2.80
15/32	6 1/4	3 3/4	1.30	2.85
1/2	6 1/2	4	1.30	2.90
17/32	6 1/2	4	1.35	2.95
9/16	6 1/2	4	1.35	3.00
19/32	6 1/2	4	1.40	3.10
5/8	6 1/2	4	1.40	3.20
21/32	6 1/2	4	1.45	3.30
11/16	6 1/2	4	1.45	3.40
23/32	6 1/2	4	1.50	3.50
3/4	6 1/2	4	1.55	3.65
25/32	6 3/4	4 3/16	1.65	3.80
13/16	7	4 7/16	1.75	4.00
27/32	7 1/4	4 11/16	1.90	4.20
7/8	7 1/2	4 15/16	2.05	4.50
29/32	7 3/4	5 3/16	2.20	4.70
15/16	8	5 7/16	2.30	5.00
31/32	8 1/4	5 11/16	2.40	5.25
1	8 1/2	5 15/16	2.55	5.50
1 1/32	8 3/4	6 3/16	2.70	5.75
1 1/16	9	6 7/16	2.85	6.00
1 3/32	9	6 7/16	3.00	6.30
1 1/8	9	6 7/16	3.10	6.70
1 5/32	9	6 7/16	3.25	7.00
1 3/16	9	6 7/16	3.35	7.30
1 7/32	9	6 7/16	3.50	7.60
1 1/4	9	6 7/16	3.65	7.90
1 9/32	9	6 7/16	3.75	8.25
1 5/16	9	6 7/16	3.90	8.60
1 11/32	9	6 7/16	4.05	9.00
1 3/8	9	6 7/16	4.20	9.40
1 13/32	9	6 7/16	4.35	9.80
1 7/16	9	6 7/16	4.50	10.20
1 15/32	9	6 7/16	4.65	10.60
1 1/2	9	6 7/16	4.80	11.00

No. 1 small shank is always furnished unless No. 2 is particularly specified.

When ordering taper square shank drills for packer ratchets, please give number of ratchet and name of manufacturer. 64th sizes furnished at price of next larger size.

UNION BIT STOCK DRILLS

FOR METAL OR WOOD

CARBON STEEL, No. 130

Fig. 15434A

EFFECTIVE JULY 1, 1917

Diameter Inches	Length Over All Inches	Twist Cut Inches	Length from Shank to Point Inches	Price per Dozen
1/32	2 7/8	9/16	1 1/16	2.25
3/64	3 3/16	25/32	1 3/8	2.40
1/16	3 3/8	1 1/4	2	2.50
5/64	3 1/2	1 3/8	2 1/8	2.60
3/32	3 5/8	1 1/2	2 1/4	2.70
7/64	3 3/4	1 11/16	2 3/8	2.85
1/8	3 7/8	1 13/16	2 1/2	3.00
9/64	4	1 15/16	2 5/8	3.25
5/32	4 1/8	2 3/32	2 3/4	3.50
11/64	4 1/4	2 7/32	2 7/8	3.75
3/16	4 3/8	2 5/16	3	4.00
13/64	4 1/2	2 7/16	3 1/8	4.25
7/32	4 5/8	2 17/32	3 1/4	4.50
15/64	5 3/16	3 3/16	3 15/16	4.75
1/4	5 3/16	3 3/16	3 15/16	5.00
17/64	5 3/8	3 3/16	4 1/8	5.50
9/32	5 3/8	3 3/8	4 1/8	6.00
19/64	5 1/2	3 3/8	4 1/4	6.50
5/16	5 1/2	3 1/2	4 1/4	7.00
21/64	5 7/8	3 1/2	4 5/8	7.50
11/32	5 7/8	3 7/8	4 5/8	8.00
23/64	5 7/8	3 7/8	4 5/8	8.50
3/8	5 7/8	3 7/8	4 5/8	9.25
13/32	6 1/4	3 5/8	5	10.50
7/16	6 5/8	4	5 3/8	11.75
15/32	6 3/4	4 3/8	5 1/2	13.00
1/2	7 1/2	4 7/16	6 1/4	14.25
17/32	7 1/2	5 3/16	6 1/4	15.50
9/16	7 1/2	5 3/16	6 1/4	16.75
19/32	7 1/2	5 3/16	6 1/4	18.00
5/8	7 1/2	5 1/16	6 1/4	19.50
21/32	7 1/2	5 1/16	6 1/4	21.00
11/16	7 1/2	5 1/16	6 1/4	22.50
23/32	7 1/2	5 1/16	6 1/4	24.00
3/4	7 1/2	5	6 1/4	25.50
25/32	7 1/2	5	6 1/4	27.00
13/16	7 1/2	5	6 1/4	28.50
27/32	7 1/2	5	6 1/4	30.00
7/8	7 1/2	5	6 1/4	31.50
29/32	7 1/2	5	6 1/4	33.00
15/16	7 1/2	4 15/16	6 1/4	34.50
31/32	7 1/2	4 15/16	6 1/4	36.00
1	7 1/2	4 15/16	6 1/4	39.00
1 1/16	7 1/2	4 7/8	6 1/4	42.00
1 1/8	7 1/2	4 7/8	6 1/4	45.00
1 3/16	7 1/2	4 7/8	6 1/4	48.00
1 1/4	7 1/2	4 7/8	6 1/4	

Bit stock drills may be used in drilling iron, steel or wood. They will fit any brace in the market.

UNION BIT STOCK DRILL AND REAMER SETS

EFFECTIVE JULY 2, 1917

BIT STOCK DRILL SETS

Fig. 15450A

SET No. 14A

Fig. 15450B

SET No. 13

Consists of the following bit stock drills: $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{7}{32}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$.

Furnished in a round, polished, wood case.

Price, Complete.....per set **4.25**

SET No. 14

Consists of the following bit stock drills: $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{7}{32}$, $\frac{1}{4}$.

Furnished in a round, polished, wood case similar to set No. 13.

Price, Complete, per set **2.70**

SET No. 13

Fig. 15450C

SET No. 14A

Consists of the following bit stock drills: $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{7}{32}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$.

Furnished in a neat, flat leatherette case, of a size suitable for carrying in the pocket.

Price, Complete.....per set **4.35**

BIT STOCK DRILL AND REAMER SETS

SET No. 15

Fig. 15450D

Consists of the following stock drills: $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$ and 1 taper square reamer bit.

Furnished in a round, polished, wood case.

Price, Complete.....per set **4.80**

Fig. 15450E

Fig. 15450F

COMBINED DRILL AND COUNTERSINK SETS

SET No. 17

Consists of the following: 1, 3, 4, 6, 7, 9, 10, 11.

Furnished with round, polished, wood case.

Price, Set including Box.....per set **2.00**

UNION STRAIGHT SHANK DRILL SETS

WIRE GAUGE AND LETTER SIZES

MOUNTED

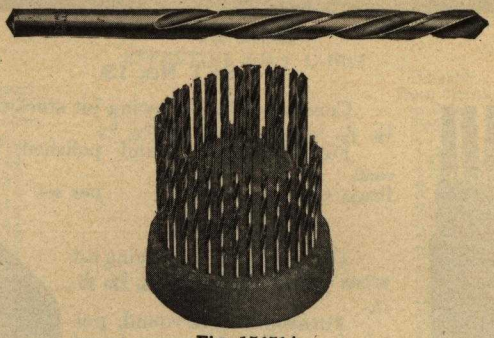


Fig. 15451A

EFFECTIVE JULY 1, 1917

Price, No. 8, Set of Wire Gauge Sizes, Nos. 1 to 60	per set	12.50
" " 9, Half Set Wire Gauge Sizes, Alternate Numbers from Nos. 1 to 59	per half set	7.00
" No. 15, Set of Letter Sizes, A to Z	per set	12.00
" " 17 " " Wire Gauge Sizes, Nos. 1 to 80	"	15.25
" Blocks without Drills for Sets Nos. 8, 9 and 15	each	2.00
" " " " " Set No. 17	"	2.25

WIRE GAUGE AND JOBBERS' LENGTH

MOUNTED

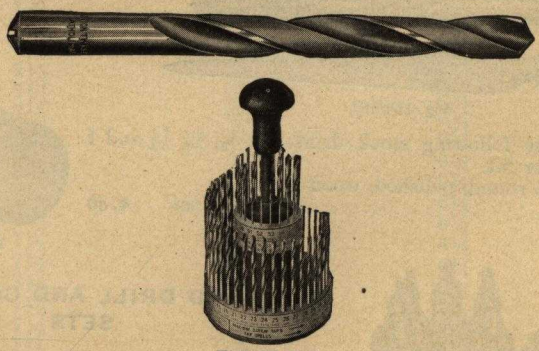


Fig. 15451B

These blocks are made of metal and are practically indestructible and have many special features in the saving of time. Each hole is stamped with size of drill, also the decimal equivalent and tap drill sizes. The handle may be removed and screwed in the inside of block for convenience in storing in tool box for shipping.

Price, No. 18, Set of Jobbers' Drills, 1/16 to 1/2 Graduated by 64ths	per set	16.50
" " 19 " " Wire Gauge Sizes, Nos. 1 to 60	"	14.50
" Blocks	each	2.75

UNION DRILL SETS

TAPER SHANK DRILL SETS

Fig. 15483A

EFFECTIVE JULY 1, 1917

No.	Sets of Taper Shank Drills	Price per Set
1	1/4 to 1 inch varying by 16ths	22.40
2	3/8 " 1 1/4 " " " 16ths	40.10
3	3/8 " 3/4 " " " 32nds, 15/16 to 1 1/4 inches varying by 16ths	48.50
4	3/8 " 3/4 " " " 32nds, 15/16 " 1 1/2 " " " 16ths	186.00
4	1 9/16 " 2 inches " " 16ths	186.00
11	3/8 " 1 1/2 " " " 32nds	345.30
11	1 17/32 " 2 " " " 32nds	345.30

NOTE.—Prices of sets of straight shank taper length drills will be the same as above list.

JEWELERS' SET OF DRILLS

MOUNTED IN MAHOGANY CASE

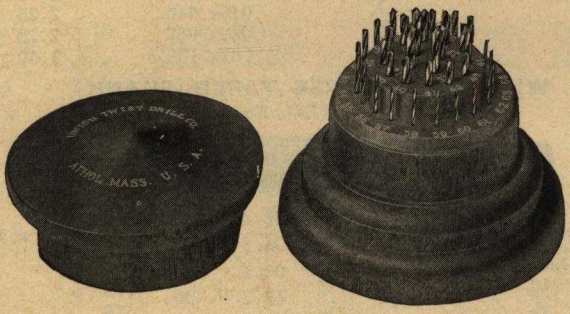


Fig. 15483B

Price, No. 10, Jewelers' Set of 36 Drills, No. 30 (1/8-inch) to No. 65 Steel Wire Gauge, Mounted in a Case with Cap ..... per set 8.00
" Jewelers' Case without Drills ..... " 2.00

STRAIGHT SHANK DRILL SETS

MOUNTED—JOBBERS' LENGTH

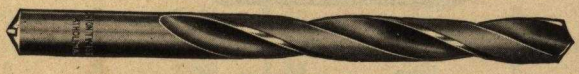


Fig. 15483C

No.	Set of Jobbers' Drills	Price per Set
5	1/16 to 1/2 inch varying by 64ths	13.50
6	1/16 " 1/2 " " " 32nds	8.00
7	Set of Jobbers' and Wire Gauge Drills, Nos. 1 to 60 and 1/4 to 3/8 inch, varying by 32nds, 65 drills	14.50
..	Blocks without Drills for Above Sets	2.00

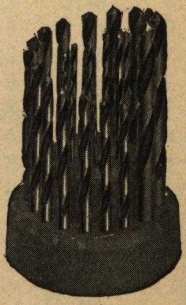


Fig. 15483D

UNION COMBINED DRILLS AND COUNTERSINKS

CARBON STEEL, No. 245 **HIGH SPEED STEEL, No. 545**

Fig. 15444A

EFFECTIVE JULY 1, 1917

Included angle 60°. Other angles made to order at special prices.

No.	Diameter of Drill at A B	Approximate Fractional Equivalents	Diameter of Body C	Decimal Equivalents A B	Price, per Dozen Carbon Steel	Price, per Dozen High Speed Steel
1	57x57	3/64	1/8	.043x.043	2.00	6.00
2	55x55	..	13/64	.052x.052	2.25	6.00
3	52x52	1/16	13/64	.063x.063	2.25	6.00
4	49x49	..	15/64	.073x.073	2.50	6.00
5	49x45	..	15/64	.073x.082	2.50	6.00
6	46x46	5/64	15/64	.081x.081	2.50	6.00
7	42x42	3/32	3/10	.093x.093	2.75	6.00
8	42x30	3/32x1/8	3/10	.093x.128	2.75	6.00
9	30x30	1/8	3/10	.128x.128	2.75	6.00
10	22x22	5/32	7/16	.157x.157	3.50	9.00
11	13x13	3/16	3/16	.185x.185	3.50	9.00
12	7/100x8/100	..	15/64	.07 x.08	2.50	6.00
13	3/64x3/64	..	5/32	.046x.046	2.25	6.00
14	1/16x45	..	13/64	.062x.082	2.25	6.00
15	3/16x5/32	..	7/16	.187x.156	3.50	9.00

WITH No. 1 MORSE TAPER SHANK

CARBON STEEL, No. 250

Fig. 15444B

No.	Diameter of Drill Inches	Diameter of Body Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
21	1/16	7/16	.75	2.25
22	3/32	7/16	.75	2.25
23	1/8	7/16	.75	2.25
24	5/32	7/16	.75	2.25
25	3/16	7/16	.75	2.25

FITTING BLACKSMITHS' DRILL PRESSES

CARBON STEEL. No. 255

Fig. 15444C

Bodies 1/2 inch or .647 (5/8 inch) diameter flatted.

No.	Diameter of Drill A B	Diameter of Body Inches	Price per Dozen Carbon Steel	No.	Diameter of Drill A B	Diameter of Body Inches	Price per Dozen Carbon Steel
31	7/32 7/32	1/2	4.60	37	7/32 7/32	5/8	7.25
32	7/32 9/32	1/2	4.60	38	7/32 9/32	5/8	7.25
33	9/32 9/32	1/2	4.60	39	9/32 9/32	5/8	7.25
34	11/32 11/32	1/2	5.00	40	11/32 11/32	5/8	7.75
35	11/32 13/32	1/2	5.00	41	11/32 13/32	5/8	7.75
36	13/32 13/32	1/2	5.00	42	13/32 13/32	5/8	7.75

UNION TWIST DRILLS

FITTING COES BLACKSMITHS' DRILL PRESSES

CARBON STEEL, No. 145 HIGH SPEED STEEL, No. 545

STYLE No. 1

Fig. 15426A

STYLE No. 2

Fig. 15426B

EFFECTIVE JULY 1, 1917

Diam. Inches	Length Over All Inches	Twist Cut Inches	—Price, Each— Carbon Steel	High Speed Steel	Diam. Inches	Length Over All Inches	Twist Cut Inches	—Price, Each— Carbon Steel	High Speed Steel
1/8	4 7/8	2 3/16	.50	....	27/32	6	3	2.00	3.15
5/32	5 1/8	2 7/16	.55	....	7/8	6	3	2.10	3.30
3/16	5 1/2	2 13/16	.60	....	29/32	6	3	2.20	3.50
7/32	5 3/4	3	.65	....	15/16	6	3	2.30	3.70
1/4	5 7/8	3	.70	1.20	31/32	6	3	2.40	3.90
9/32	6	3	.75	1.30	1	6	3	2.50	4.10
5/16	6	3	.80	1.40	1 1/32	6	3	2.60	4.30
11/32	6	3	.85	1.50	1 1/16	6	3	2.70	4.50
3/8	6	3	.90	1.55	1 3/32	6	3	2.80	4.75
13/32	6	3	.95	1.65	1 1/8	6	3	2.90	5.00
7/16	6	3	1.00	1.70	1 5/32	6	3	3.00	5.25
15/32	6	3	1.05	1.80	1 3/16	6	3	3.10	5.50
1/2	6	3	1.10	1.85	1 7/32	6	3	3.20	5.80
17/32	6	3	1.15	1.95	1 1/4	6	3	3.30	6.10
9/16	6	3	1.20	2.05	1 9/32	6	3	3.45	6.40
19/32	6	3	1.25	2.20	1 5/16	6	3	3.60	6.70
5/8	6	3	1.30	2.30	1 11/32	6	3	3.75	7.00
21/32	6	3	1.40	2.40	1 3/8	6	3	3.90	7.40
11/16	6	3	1.50	2.50	1 13/32	6	3	4.05	7.80
23/32	6	3	1.60	2.65	1 7/16	6	3	4.20	8.20
3/4	6	3	1.70	2.75	1 15/32	6	3	4.35	8.60
25/32	6	3	1.80	2.90	1 1/2	6	3	4.50	9.00
13/16	6	3	1.90	3.00	...	..	..	....	....

Shank 5/8 inch (.647 exact) in diameter, 2 1/4 inches long. Style No. 2 always furnished unless otherwise ordered. 64th sizes furnished at price of next larger size.

UNION DRILL SOCKETS, DRILL SLEEVES, ETC.

STEEL SOCKETS, No. 400

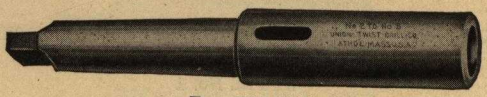


Fig. 15436A

Inside Morse Taper No.	Morse Taper Shank No.	Price Each	Inside Morse Taper No.	Morse Taper Shank No.	Price Each	Inside Morse Taper No.	Morse Taper Shank No.	Price Each
1	2	**2.00**	2	5	**4.80**	4	4	**4.80**
1	3	**2.50**	3	2	**3.20**	4	5	**4.80**
1	4	**3.20**	3	3	**3.20**	4	6	**12.00**
1	5	**4.80**	3	4	**3.20**	5	4	**12.00**
2	3	**2.50**	3	5	**4.80**	5	5	**12.00**
2	4	**3.20**	4	3	**4.80**	5	6	**12.00**

These sockets can be furnished hardened and ground, inside and outside. Prices quoted upon application.

STEEL SLEEVES, No. 405

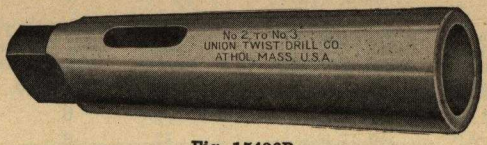


Fig. 15436B

Morse Inside Taper.....number	1	1	1	1	2	2
" Outside Taper..... "	2	3	4	5	3	4
Price.....each	**1.80**	**2.40**	**3.00**	**4.40**	**2.40**	**3.00**
Morse Inside Taper.....number	2	3	3	4	4	5
" Outside Taper..... "	5	4	5	5	6	6
Price.....each	**4.40**	**3.00**	**4.40**	**4.40**	**10.00**	**10.00**

These sleeves can be furnished hardened and ground, inside and outside. Prices quoted upon application.

STEEL SOCKETS, BLANK END
No. 410

Fig. 15436C

Socket.....number	1	2	3	4	5	6
Morse Inside Taper..... "	1	2	3	4	5	6
Whole Length.....inches	7	8	10	13	15	18
Diameter of Blank End..... "	1⅛	1¼	1½	2	2½	3
Length of Blank End..... "	3⅞	4¼	5⅜	7⅜	8	8¾
Price.....each	**1.20**	**1.80**	**2.50**	**4.00**	**7.50**	**14.00**

Prices include plug for use in turning shank. Sockets for oil-hole drills can be furnished when so required.

UNION LATHE SOCKETS, COLLETS, ETC.

LATHE SOCKETS, No. 415

Fig. 15452A

These sockets are hardened.

Number	1	2	3	4	5
" Morse Taper Inside	1	2	3	4	5
Price.....each	1.20	1.80	2.50	4.00	7.50

The end is deeply countersunk thus insuring a good bearing for lathe center.

MILLING MACHINE COLLETS, No. 420

Fig. 15452B

Number	A	N	C	B	EE	E
" B. & S. Taper Inside	4	5	5	7	5	7
" B. & S. " Outside	7	7	9	9	10	10
Price.....each	2.75	2.75	3.75	4.50	5.00	5.00
Number	F	Q	G	P	*T	*PP
" B. & S. Taper Inside	9	7	9	10	9	10
" " " Outside	10	11	11	11	12	12
Price.....each	5.50	6.00	6.50	8.75	8.75	8.75

*Made with clutch drive and without tongue on end. Sockets for oil-hole drills can be furnished when so desired.

COLLET BLANKS, No. 425

Fig. 15452C

Diameter.....inches	3/4	1 1/8	1 5/8	1 5/8	2
Length Over All..... "	5 1/4	8 1/2	10	12	14
Number, B. & S. Taper Inside	4	5	7	9	10
Price.....each	2.50	2.75	3.25	5.00	6.00

Price includes plug for use in turning shanks.

CENTER KEYS, No. 430

Fig. 15452D

Steel drop-forgings hardened and finished.

Key Number	1	2	3	4	5	6
Number, Fitting Socket or Sleeve	1	2	3	4	5	6
Price.....each	.30	.35	.40	.50	.60	.75

USE-EM-UP DRILL SOCKETS

SLEEVE TYPE

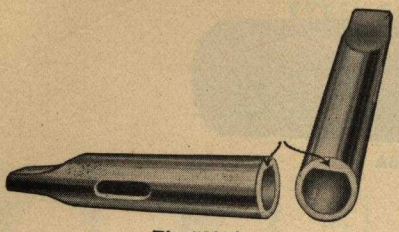


Fig. 5912A

To be used in connection with twist drills which have had the tangs twisted off. All that is necessary is to grind a flat on the remaining portion of the shank (time 3 minutes.)

Size No.	Number of Hole	Fitted to Socket Number	Price Each
1–2	1	2	1.80
1–3	1	3	2.40
1–4	1	4	3.00
1–5	1	5	4.40
2–3	2	3	2.40
2–4	2	4	3.00
2–5	2	5	4.40
3–4	3	4	3.00
3–5	3	5	4.40
4–5	4	5	4.40
4–6	4	6	10.00
5–6	5	6	10.00

Use-Em-Up Drill Sockets are intended for using up twist drills or reamers having broken shanks or twisted tangs.

These sockets will drive a drill where only three-quarters of an inch of the shank remains. All that is necessary is to grind a flat surface on the remaining shank of the drill or reamer and put it to work.

When making boring bars, the expense of milling a tang is unnecessary; simply flat one side and use the Use-Em-Up Socket.

A man actually bought 43 good twist drills for 25 cents.

He stood in the yard of one of the plants of a large brake shoe company watching them unload a car of scrap from an eastern railroad.

SOCKET TYPE

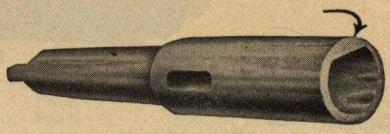


Fig. 5912B

When ordering new drills, specify on your order, Flatted for Use-Em-Up Sockets, and you will not have any trouble with twisted tangs. All leading drill manufacturers will flat their drills at no extra charge.

Size No.	Number of Hole	Fitted to Socket Number	Price Each
1–2	1	2	2.00
1–3	1	3	2.50
1–4	1	4	3.20
1–5	1	5	4.80
2–3	2	3	2.50
2–4	2	4	3.20
2–5	2	5	4.80
3–2	3	2	3.20
3–3	3	3	3.20
3–4	3	4	3.20
3–5	3	5	4.80
4–3	4	3	4.80
4–4	4	4	4.80
4–5	4	5	4.80
4–6	4	6	12.00
5–4	5	4	12.00
5–5	5	5	12.00
5–6	5	6	12.00

He picked out 43 good twist drills, gave the superintendent a quarter and took them away. True, the tangs were twisted off, and on some the shank was broken so that there was only three-quarters of an inch of shank left, but it was only necessary to grind a flat on them (time, two minutes per drill) and put them in the Use-Em-Up Drill Socket to make them as good as ever.

DRILL SPEEDS AND FEEDS

REVOLUTIONS PER MINUTE

Diameter of Drills, Inches	Wrought Iron and Steel	Cast Iron	Brass	Diameter of Drills, Inches	Wrought Iron and Steel	Cast Iron	Brass
1/16	1834.	2140.	3668.	1 1/8	102.	119.	204.
1/8	917.	1070.	1834.	1 1/4	91.8	107.	183.
3/16	611.	713.	1222.	1 3/8	83.3	97.2	167.
1/4	458.	535.	917.	1 1/2	76.3	89.2	153.
5/16	367.	428.	733.	1 5/8	70.5	82.2	141.
3/8	306.	357.	611.	1 3/4	65.5	76.4	131.
7/16	262.	306.	524.	1 7/8	61.1	71.3	122.
1/2	229.	268.	459.	2	57.3	66.9	115.
5/8	184.	214.	367.	2 1/4	51.0	59.4	102.
3/4	153.	178.	306.	2 1/2	45.8	53.5	91.7
7/8	131.	153.	262.	2 3/4	41.7	48.6	83.4
1	115.	134.	229.	3	38.2	44.6	76.4

A feed per revolution of .004 to .007 inch for drills 1/4-inch and smaller, and from .007 to .015-inch for larger is about all that should be required.

This feed is based on a peripheral speed of a drill equal to:

30 feet per minute for steel;
35 feet per minute for iron;
60 feet per minute for brass.

It may also be found advisable to vary the speed somewhat according as the material to be drilled is more or less refractory.

We believe that these speeds should not be exceeded.

If the outer corners wear it shows that the speed is too high and it should be reduced. This is particularly noticeable in drilling cast iron. If the drill chips on the edge or if it splits in the web, it is either ground improperly or the feed is altogether too heavy.

FOR HIGH SPEED DRILLS

DOUBLE THE ABOVE SPEEDS

CUTTING SPEEDS FOR TOOLS

Work Diameter	Feet Per Minute								
	20	30	40	50	60	70	80	90	100
	Revolutions Per Minute								
2	37	55	74	92	111	130	149	166	184
3	25	37	50	62	74	86	98	110	124
4	18	28	37	46	56	65	74	84	93
5	15	23	30	38	46	53	61	69	76
6	13	19	25	31	37	43	49	55	62
7	11	16	21	27	32	37	42	48	54
8	9	14	19	23	28	33	38	42	46
9	8	12	17	21	25	29	34	38	42
10	7	11	15	19	23	26	30	34	38
11	7	10	14	17	20	24	27	31	34
12	6	9	12	15	18	22	25	28	32
14	5	8	11	13	16	19	21	24	27
16	5	7	9	11	14	16	19	21	23
18	4	6	8	10	12	14	17	19	21
20	4	5	7	9	11	13	15	17	19
22	3	5	7	8	10	12	13	15	17
24	3	4	6	7	9	11	12	14	16

TAP DRILLS

Drills for tapped holes, when theoretically correct, figure out as a rule in odd thousandths of an inch, thus calling for special drills. To avoid making them to order, we have in the following lists selected drills of an approximate size, which will permit using the regular stock drills. In some cases it may be advisable to use larger drills, and in some cases smaller drills, depending on how full a thread it is desired to obtain, the amount allowed for clearance varying with different manufacturers and on different classes of work.

FOR TAPS WITH V THREAD

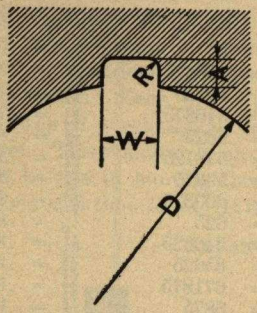
Size of Tap	No. of Threads	Size of Drill
3/32	48	50
3/32	52	50
3/32	54	49
3/32	56	49
3/32	60	48
7/64	32	50
7/64	36	49
7/64	40	47
7/64	48	44
7/64	56	43
1/8	32	44
1/8	36	43
1/8	40	42
1/8	42	41
1/8	48	39
9/64	30	41
9/64	32	40
9/64	36	37
9/64	40	34
5/32	30	33
5/32	32	32
5/32	36	31
5/32	40	30
11/64	32	30
11/64	36	29
11/64	40	28
3/16	24	No. 29
3/16	28	28
3/16	30	27
3/16	32	26
3/16	36	24
13/64	24	26
13/64	28	22
13/64	32	20
13/64	36	18
7/32	24	20
7/32	28	17
7/32	30	16
7/32	32	15
15/64	24	16
15/64	28	12
15/64	32	10
1/4	18	17
1/4	20	14
1/4	24	9
9/32	16	10
9/32	18	13/64 in.
9/32	20	No. 3
5/16	16	No. 1
5/16	18	15/64 in.
11/32	16	F
11/32	18	17/64 in.
3/8	14	J
3/8	16	L
3/8	18	19/64 in.
13/32	14	N
13/32	16	P
13/32	18	21/64 in.
7/16	14	R
7/16	16	S
15/32	14	3/8
15/32	16	W
1/2	12	25/64 in.
1/2	13	X
1/2	14	13/32
17/32	12	27/64
17/32	13	27/64
17/32	14	7/16
9/16	12	29/64
9/16	14	15/32
19/32	12	31/64
19/32	14	1/2
5/8	10	31/64
5/8	11	1/2
5/8	12	33/64
21/32	10	33/64
21/32	11	17/32
21/32	12	35/64
11/16	11	9/16
11/16	12	37/64
23/32	11	19/32
23/32	12	39/64
3/4	10	39/64
3/4	11	5/8
3/4	12	41/64
25/32	10	41/64
25/32	11	21/32
25/32	12	43/64
13/16	10	43/64
27/32	10	45/64
7/8	9	23/32
7/8	10	47/64
29/32	9	3/4
15/16	9	25/32
31/32	9	13/16
1	8	53/64
1 1/32	8	55/64
1 1/16	8	57/64
1 3/32	8	59/64
1 1/8	7	59/64
1 1/8	8	61/64
1 5/32	7	61/64
1 5/32	8	63/64
1 3/16	7	63/64
1 3/16	8	1 1/64
1 7/32	7	1 1/64
1 7/32	8	1 3/64
1 1/4	7	1 3/64
1 9/32	7	1 5/64
1 5/16	7	1 7/64
1 11/32	7	1 9/64
1 3/8	6	1 1/8
1 13/32	6	1 5/32
1 7/16	6	1 3/16
1 15/32	6	1 7/32
1 1/2	6	1 17/64
1 17/32	6	1 19/64
1 9/16	6	1 21/64
1 19/32	6	1 23/64
1 5/8	5	1 21/64
1 5/8	5 1/2	1 23/64
1 21/32	5	1 23/64
1 21/32	5 1/2	1 25/64
1 11/16	5	1 25/64
1 11/16	5 1/2	1 27/64
1 23/32	5	1 27/64
1 23/32	5 1/2	1 29/64
1 3/4	5	1 29/64
1 25/32	5	1 31/64
1 13/16	5	1 33/64
1 27/32	5	1 35/64
1 7/8	4 1/2	1 35/64
1 7/8	5	1 37/64
1 29/32	4 1/2	1 37/64
1 29/32	5	1 39/64
1 15/16	4 1/2	1 39/64
1 15/16	5	1 41/64
1 31/32	4 1/2	1 41/64
1 31/32	5	1 43/64
2	4 1/2	1 43/64

INSTRUCTIONS FOR ORDERING UNION MILLING CUTTERS

1919 REVISION

SUGGESTIONS AND ADVICE REGARDING SIZES COMMONLY USED

STANDARD KEYWAYS



One cause of possible delay in the prompt filling of orders for special cutters is the failure to specify the size of keyway desired, where it is other than standard. The standard keyways correspond as a rule with the keys in the arbors supplied with the majority of the domestic machine tools, but this is not universally so, therefore, it is necessary to state clearly the size of keyway required.

Diameter of Hole (D) in Cutter Inches	Width (W) Inches	Depth (A) Inches	Radius (R) Inches
3/8 to 9/16	3/32	3/64	.020
5/8 " 1 7/8	1/8	1/16	.030
15/16 " 1 1/8	5/32	5/64	.035
1 3/16 " 1 3/8	3/16	3/32	.040
1 7/16 " 1 3/4	1/4	1/8	.050
1 13/16 " 2	5/16	5/32	.060
2 1/16 " 2 1/2	3/8	3/16	.060
2 9/16 " 3	7/16	3/16	.060

All gear cutters 1½, 1¾ and 2-inch holes have 5/16, 3/8, and ½-inch keyways, respectively, excepting those with 1½-inch hole which can also be furnished with 3/8-inch keyway.

Union products are the result of many years' experience in the line of manufacturing special machinery and appliances for the production of cutters, drills and reamers of quality.

The tools are thoroughly made and are thoroughly inspected as to accuracy and workmanship.

SUGGESTIONS WHEN ORDERING

STOCK CUTTERS

In ordering, use the names or numbers as shown in catalogue. This will save delay.

SPECIAL CUTTERS

Always state distinctly type of cutter required, giving dimensions in full. For cutters made with a shank, angular cutters and cutters with threaded holes, state whether right or left-hand is required.

FORMED CUTTERS

A drawing showing all dimensions and if possible a template should be furnished. Always indicate on drawing, direction of revolution of cutter, that is, whether the cutter runs "coming" or "going" at bottom. State what conditions and the character of material on which cutter is to be used.

GEAR CUTTERS

Give number and pitch, stating clearly whether diametral or circular pitch. Also diameter, size of hole, and keyway.

The manufacturer is prepared to lay out and design cutters in gangs for all milling operations, and submit estimates and drawings upon receipt of necessary data.

HIGH POWER MILLING CUTTERS

These cutters have a less number of teeth than the old form which is commonly referred to as standard. The teeth are widely spaced, allowing about four times the chip room of standard cutters.

It will also be noted that the teeth are undercut, this being the latest development in cutters, and is the result of extensive experiments. A comparative idea of this style of tooth may be had by referring to outline drawings in the following pages, the effect of this style of tooth is a shearing cut rather than the scraping cut of the radial tooth cutters.

On following pages we show this type of cutter which has been developed as a result of efforts to produce cutters adequate to the capacity of high power milling machines.

The principle consideration in the development is the ample chip room.

UNION MILLING CUTTERS

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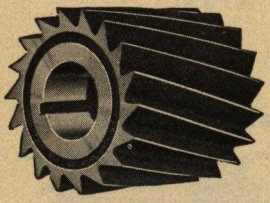


Fig. 14961A

Milling cutters have teeth spaced to give the most desirable results. The teeth are strong and well proportioned to withstand heavy cuts. Cutters listed ¾-inch face and over, have teeth of a spiral form.

No.	Diam. of Cutter Inches	Width of Face Inches	Hole in Cutter Inches	Price, per Cutter Carbon Steel	Price, per Cutter High Speed Steel
A 2	2¼	½	⅞	2.25	2.85
A 3	2¼	1	⅞	3.20	4.55
A 4	2¼	1¾	⅞	4.20	5.80
A 5	2½	3/16	1	1.65	2.10
A 6	2½	¼	1	1.80	2.30
A 7	2½	5/16	1	2.00	2.55
A 8	2½	⅜	1	2.10	2.65
A 9	2½	7/16	1	2.20	2.80
A10	2½	½	1	2.30	3.00
A11	2½	9/16	1	2.40	3.20
A12	2½	⅝	1	2.45	3.45
A13	2½	11/16	1	2.65	3.55
A14	2½	¾	1	2.80	3.80
A15	2½	13/16	1	2.90	4.00
A16	2½	⅞	1	3.10	4.15
A18	2½	1	1	3.30	4.55
A20	2½	1¼	1	3.70	5.15
A21	2½	1½	1	4.00	5.65
A22	2½	1¾	1	4.35	6.30
A23	2½	2	1	4.75	6.90
A25	2½	2½	1	5.25	7.85
A27	2½	3	1	5.70	8.80
A29	2½	4	1	7.00	11.00
A32	2¾	3/16	1	1.75	2.20
A33	2¾	¼	1	2.00	2.50
A34	2¾	5/16	1	2.10	2.70
A35	2¾	⅜	1	2.30	2.90
A36	2¾	7/16	1	2.35	3.20
A37	2¾	½	1	2.40	3.30
A38	2¾	9/16	1	2.55	3.55
A39	2¾	⅝	1	2.70	3.90
A41	2¾	¾	1	3.20	4.35
A43	2¾	⅞	1	3.65	4.95
A45	2¾	1	1	4.00	5.35

Above can be furnished with coarse teeth and undercut teeth, prices quoted upon application.

No.	Diam. of Cutter Inches	Width of Face Inches	Hole in Cutter Inches	Price, per Cutter Carbon Steel	Price, per Cutter High Speed Steel
A47	2¾	1¼	1	4.35	6.10
A48	2¾	1½	1	4.80	6.80
A50	2¾	2	1	5.35	7.95
A51	2¾	2½	1	5.85	9.00
A52	2¾	3	1	6.40	10.00
A54	2¾	4	1¼	7.65	12.65
A57	3	3/16	1	1.75	2.35
A58	3	¼	1	2.10	2.75
A59	3	5/16	1	2.35	3.20
A60	3	⅜	1	2.70	3.55
A61	3	⅜	1¼	2.70	3.55
A63	3	7/16	1¼	2.85	3.85
A65	3	½	1¼	3.10	4.10
A66	3	9/16	1¼	3.25	4.40
A67	3	⅝	1¼	3.45	4.70
A69	3	¾	1¼	3.85	5.20
A71	3	⅞	1¼	4.20	5.75
A73	3	1	1¼	4.55	6.35
A74	3	1¼	1¼	5.10	7.20
A75	3	1½	1¼	5.45	7.85
A76	3	1¾	1¼	5.70	8.45
A77	3	2	1¼	6.00	9.00
A78	3	2½	1¼	6.60	10.35
A79	3	3	1¼	7.00	11.20
A80	3	3½	1¼	7.50	12.50
A81	3	4	1¼	8.15	13.80
A82	3	5	1¼	9.90	16.90
A83	3	6	1¼	13.70	22.15
A84	3½	3/16	1	1.85	2.65
A85	3½	¼	1	2.20	3.10

Above can be furnished with coarse teeth and undercut teeth, prices upon application.

We call attention to the Union High Power Cutter. It is the intention of the factory not only to produce tools of the highest possible quality, but also to develop along progressive lines, as conditions may warrant new types of cutters capable of producing more and better work.

Their efforts along this line have resulted in placing on the market the High Power Cutter and later the undercut type.

It is the policy of the factory to give real assistance to cutter users, and their entire organization is at your disposal.

UNION MILLING CUTTERS

CONTINUED

1919 REVISION

MILLING CUTTERS

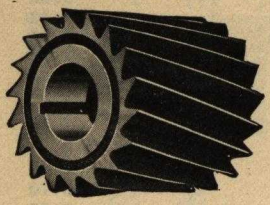


Fig. 14962A

No.	Diam. of Cutter Inches	Width of Face Inches	Hole in Cutter Inches	Price per Cutter Carbon Steel	Price per Cutter High Speed Steel
A86	3½	5/16	1	2.65	3.65
A87	3½	3/8	1	3.10	4.25
A88	3½	7/16	1	3.50	4.40
A89	3½	½	1¼	4.00	5.45
A91	3½	5/8	1¼	4.40	6.05
A93	3½	¾	1¼	4.90	6.80
A95	3½	7/8	1¼	5.55	7.70
A97	3½	1	1¼	6.10	8.25
A99	3½	1½	1¼	7.10	10.00
A101	3½	2	1¼	8.15	12.30
A102	3½	2½	1¼	8.75	13.80
A103	3½	3	1¼	9.40	15.35
A104	3½	3½	1¼	10.35	16.70
A105	3½	4	1¼	11.60	19.30
A105¼	3½	4	1½	11.60	19.30
A108	4	¼	1	2.60	3.80
A109	4	¼	1¼	2.60	3.80
A110	4	5/16	1	3.20	4.55
A111	4	5/16	1¼	3.20	4.55
A112	4	3/8	1	3.85	5.35
A113	4	3/8	1¼	3.85	5.35
A114	4	7/16	1¼	4.45	6.15
A115	4	½	1¼	5.00	6.85
A117	4	9/16	1¼	5.20	7.25
A118	4	5/8	1¼	5.45	7.65
A120	4	¾	1¼	6.00	8.45
A123	4	7/8	1¼	6.55	9.30
A125	4	1	1¼	7.15	10.25
A126	4	1	1½	7.15	10.25
A127	4	1¼	1¼	7.90	11.60
A128	4	1¼	1½	7.90	11.60
A129	4	1½	1¼	8.40	12.70
A130	4	1½	1½	8.40	12.70
A131	4	1¾	1¼	9.00	13.70
A132	4	1¾	1½	9.00	13.70
A133	4	2	1¼	9.45	14.85

MILLING CUTTERS

No.	Diam. of Cutter Inches	Width of Face Inches	Hole in Cutter Inches	Price per Cutter Carbon Steel	Price per Cutter High Speed Steel
A134	4	2	1½	9.45	14.85
A136	4	3	1	11.45	19.10
A137	4	3	1½	11.45	19.10
A139	4	4	1	14.00	23.95
A140	4	4	1½	14.00	23.95
A142	4	5	1½	17.10	28.95
A144	4	6	1½	19.65	34.45
A150	4½	½	2	5.10	7.50
A154	4½	5/8	2	5.60	8.60
A158	4½	¾	2	6.10	9.60
A160	4½	7/8	2	6.70	10.50
A162	4½	1	2	7.50	11.55
A164	4½	1¼	2	8.60	13.00
A166	4½	1½	2	9.50	14.60
A168	4½	1¾	2	10.45	16.30
A170	4½	2	2	10.80	18.00
A171	4½	6	2	24.70	45.10

Above can also be furnished with coarse teeth and undercut teeth.

FEEDS AND SPEEDS

The feeds and speeds of cutters cannot be governed by any definite rules, but, in a general way the following surface speeds will serve to give an idea, or basis to work from.

They may be varied slightly to suit the requirements of the work in hand. Using carbon steel cutters. For brass, 80 feet to 100 feet per minute; for cast iron, 40 feet to 60 feet per minute; and for annealed tool steel, 20 feet to 30 feet per minute have been found satisfactory. With high speed steel cutters for the same materials, the following speeds are advocated; For brass, 150 to 200 feet per minute; for cast iron, 80 to 100 feet per minute; for machinery steel, 80 to 100 feet per minute; and for annealed tool steel, 60 to 80 feet per minute.

Tables for determining the number of revolutions per minute to obtain the more common surface speeds of cutters of different diameters, will be found in the useful information pages.

UNION SIDE MILLING CUTTERS

TEETH CUT ON FACE AND SIDES

1919 REVISION

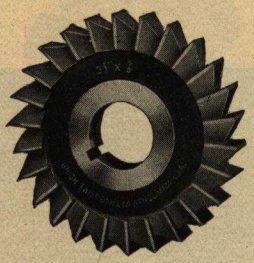


Fig. 14964A

These cutters are frequently used in pairs for sizing nuts, bolt heads, etc., and when so used are called straddle mills.

In grinding the teeth of side milling cutters, the manufacturer has employed a method of his own, which provides properly cleared and sharp cutting points.

These cutters are occasionally used in gangs, and in such cases advise so that uniform diameters and thickness may be furnished.

No.	Diam. of Cutter Inches	Width of Face Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
B 1	2	3/16	1/2	2.35	2.80
B 2	2	1/4	1/2	2.60	3.00
B 3	2	3/8	1/2	2.80	3.25
B 4	2	3/16	5/8	2.35	2.80
B 5	2	1/4	5/8	2.60	3.00
B 6	2	3/8	5/8	2.80	3.25
B 7	2 1/2	1/4	7/8	2.80	3.30
B 8	2 1/2	5/16	7/8	2.90	3.60
B 9	2 1/2	3/8	7/8	3.15	3.70
B10	2 1/2	7/16	7/8	3.25	3.85
B11	2 1/2	1/2	7/8	3.40	4.10
B12	2 3/4	1/4	7/8	2.90	3.55
B13	2 3/4	5/16	7/8	3.20	3.80
B14	2 3/4	3/8	7/8	3.40	4.00
B15	2 3/4	7/16	7/8	3.50	4.35
B16	2 3/4	7/16	1	3.50	4.35
B17	2 3/4	1/2	7/8	3.60	4.45
B18	2 3/4	1/2	1	3.60	4.45

Above can also be furnished with coarse teeth and undercut teeth. Prices quoted upon application.

No.	Diam. of Cutter Inches	Width of Face Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
B20	3	1/4	1	3.15	3.85
B21	3	5/16	1	3.50	4.35
B22	3	3/8	1	3.85	4.75
B24	3	7/16	1	4.10	5.10
B25	3	1/2	1	4.30	5.40
B26	3	1/2	1 1/4	4.30	5.40
B27	3 1/2	7/16	1	4.80	5.75
B28	3 1/2	1/2	1	5.35	6.95
B30	3 1/2	9/16	1	5.55	7.65
B31	3 1/2	5/8	1	5.80	7.65
B32	4	1/4	1	3.70	5.05
B34	4	3/8	1	5.15	6.85
B35	4	3/8	1 1/4	5.15	6.85
B36	4	1/2	1	6.50	8.55
B37	4	1/2	1 1/4	6.50	8.55
B39	4	5/8	1	7.10	9.45
B40	4	5/8	1 1/4	7.10	9.45
B41	4	3/4	1	7.65	10.40
B42	4	3/4	1 1/4	7.65	10.40
B43	4	7/8	1	8.25	11.35
B44	4	7/8	1 1/4	8.25	11.35
B54	5	1/2	1	6.70	9.80
B55	5	1/2	1 1/4	6.70	9.80
B56	5	5/8	1	7.30	11.00
B57	5	5/8	1 1/4	7.30	11.00
B58	5	3/4	1	8.10	12.45
B59	5	3/4	1 1/4	8.10	12.45
B60	5	7/8	1	8.75	13.65
B61	5	7/8	1 1/4	8.75	13.65
B62	5	1	1	9.90	15.05
B63	5	1	1 1/4	9.90	15.05
B64	6	1/2	1	8.55	12.25
B65	6	1/2	1 1/4	8.55	12.25
B67	6	5/8	1 1/4	9.10	13.80
B69	6	3/4	1	9.65	15.35
B70	6	3/4	1 1/4	9.65	15.35
B70 1/4	6	7/8	1 1/4	10.25	16.90
B73	6	1	1	11.00	18.55
B74	6	1	1 1/4	11.00	18.55
B74 1/4	6	1	1 1/2	11.00	18.55
B75	7	3/4	1 1/4	17.50	23.85
B76	7	1	1 1/4	20.40	28 95
B78	8	1	1 1/4	24.75	37.30

Above can also be furnished with coarse teeth and undercut teeth. Prices quoted upon application.

UNION MILLING CUTTERS

1919 REVISION

SIDE MILLING CUTTERS WITH INSERTED TEETH

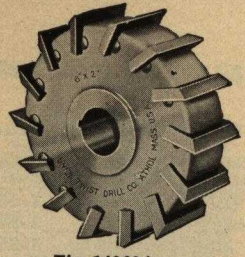


Fig. 14963A

Side milling cutters with inserted teeth have steel bodies and high speed steel inserted teeth. The improved method of securing the teeth holds them positively in position and they can be easily adjusted or replaced when worn. An economical cutter for large or heavy work.

No.	Diam. Inches	Width of Face Inches	Hole in Cutter Inches	Price, Each High Speed Steel Blades
B200	6	2	1¼	21.50
B201	7	2	1¼	24.75
B201¼	7	2	1¾	24.75
B202	8	2	1½	28.25
B202¼	8	2	2	28.25
B203	9	2	1½	32.00
B204	10	2	1½	36.00

FACE MILLING CUTTERS WITH INSERTED TEETH AND TAPER HOLES

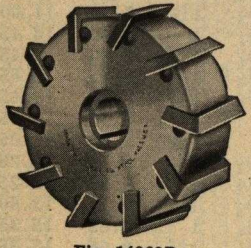


Fig. 14963B

These cutters have taper ing hole which is provided with a keyway for driving and cutter is held securely on arbor by means of a screw in the end.

No.	Diam. Inches	Thickness at Cutting Edge Inches	Length of Side Teeth Inches	Hole No. B&S Taper	Price Each High Speed Steel
C50	5½	2¼	1	10	21.25
C51	5½	2¼	1	12	22.25
C52	6½	2¼	1	10	24.25
C53	6½	2¼	1	12	25.25
C54	7½	2¼	1	12	28.25
C55	8½	2¼	1	12	32.25
C56	9½	2¼	1	12	36.25

CUTTER CASES

OAK FRONT, SIDES AND TOP

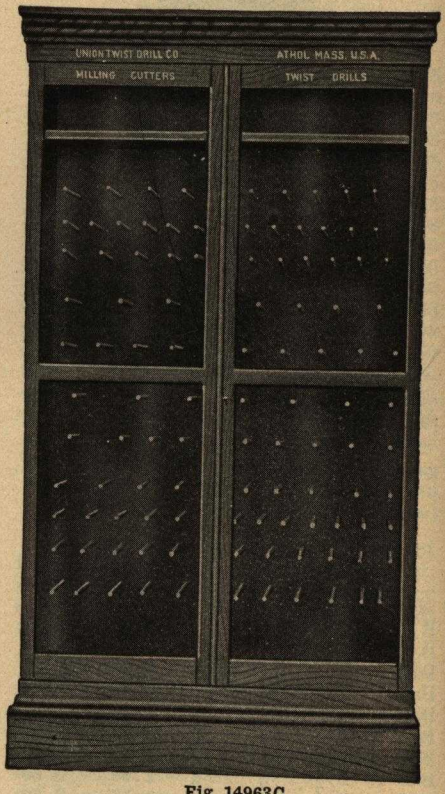


Fig. 14963C

This case is arranged for holding an assorted stock of angular cutters, gear cutters, metal splitting saws, milling cutters, screw slotting cutters, and side milling cutters.

Height	inches	71
Width	"	42
Depth	"	12

Prices quoted upon application.

UNION INVOLUTE GEAR CUTTERS

FOR THE TEETH OF GEAR WHEELS

1919 REVISION

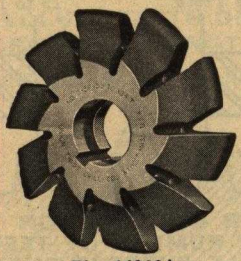


Fig. 14966A

Can be sharpened by grinding without changing their form

Patent involute gear cutters are produced from original forms by use of special machinery under careful supervision.

All gears of the same pitch cut out with our cutters, are interchangeable, and the care and attention given these cutters during every operation through which they pass, in the course of manufacture, insures the greatest degree of accuracy.

In the following list of gear cutters, attention is called to the different diameters and different sizes of holes. It is possible to select a cutter for almost any of the regular machines and arbors. When this can be done it is to the users' advantage.

In ordering, give the number of cutter, diametral pitch, diameter of cutter, and size of hole required. Always state if "range cutter or single purpose cutter" for exact number of teeth is wanted. A stock of cutters from 2 to 48 pitch is kept on hand.

Cutters can also be furnished to order for pinions of 6, 7, 8, 9, 10, and 11 teeth that will interchange with the regular gears.

A separate cutter is required for each pinion.

The proper grinding of cutter is a very important point and great care should be exercised to ensure that this operation is correctly performed. It is not advisable to allow cutter to become dull. They should be sharpened frequently and regularly when in constant use. It is only by using an accurately made cutter with a keen cutting edge that the best results can be obtained, both as to quantity and quality of work.

INVOLUTE GEAR CUTTERS

RANGE OF CUTTERS

According to the system adopted by the manufacture, eight cutters are required for each pitch.

These eight cutters are adapted to cut from a pinion of twelve teeth to a rack, and are numbered respectively as follows:

No. 1

No. 1 will cut wheels from 135 teeth to a rack.

No. 2

No. 2 will cut wheels from 55 teeth to 134 teeth.

No. 3

No. 3 will cut wheels from 35 teeth to 54 teeth.

No. 4

No. 4 will cut wheels from 26 teeth to 34 teeth.

No. 5

No. 5 will cut wheels from 21 teeth to 25 teeth.

No. 6

No. 6 will cut wheels from 17 teeth to 20 teeth.

No. 7

No. 7 will cut wheels from 14 teeth to 16 teeth.

No. 8

No. 8 will cut wheels from 12 teeth to 13 teeth.

HALF NUMBERS

When a finer division of teeth is required. cutters made to half numbers can be furnished.

Gears cut with these cutters will interchange with gears cut with the regular No.1 to No. 8 cutters, and on account of the smaller range covered, more accurate and running gears are produced.

The half numbers are as follows:

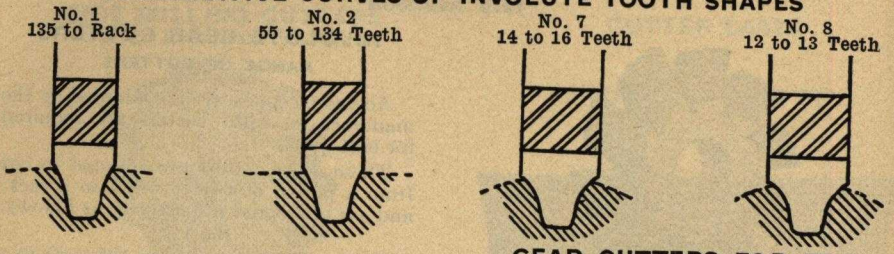
No. 1½, 80 to 134 teeth.
No. 2½, 42 to 54 teeth.
No. 3½, 30 to 34 teeth.
No. 4½, 23 to 25 teeth.
No. 5½, 19 to 20 teeth.
No. 6½, 15 to 16 teeth.
No. 7½, 13 teeth.

We are also prepared to furnish on special order, cutters for pinions of 6, 7, 8, 9, 10 and 11 teeth that will interchange with the regular gears, a separate cutter is required for each pinion.

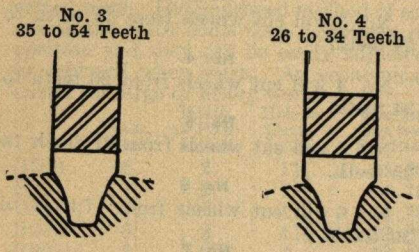
UNION INVOLUTE GEAR CUTTERS

1919 REVISION

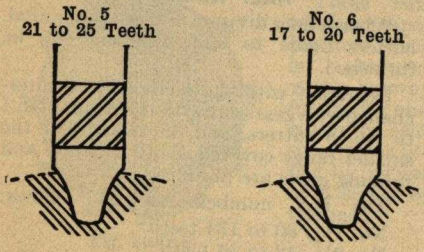
COMPARATIVE CURVES OF INVOLUTE TOOTH SHAPES



The diagrams on this page show how the curves vary in the eight different cutters necessary to make a complete set of one pitch.



It will be noticed that there is a gradual increase in the curve, of the tooth outline from the No. 1 to the No. 8 cutter which will make it clear that one cutter can not be suitable for cutting all sizes of gears.



It has been found by experiment that the set of eight cutters will cut gears from 12 teeth to a rack and give very good results, but a cutter should never be used for any gear other than those included in the range which it is designed to cut.

All gears of the same pitch cut with these cutters will be interchangeable. Cutters represent eight diametral pitch.

GEAR CUTTERS FOR THE EXACT NUMBER OF TEETH OR SINGLE PURPOSE CUTTERS

As explained and shown in the preceding tables, the regular cutters such as are commonly carried in stock are designed to take a range of sizes. It will readily be understood that the curve of the tooth form for any particular cutter is fixed, and the cutter can therefore be correct for only one size of gear or number of teeth.

It is the general practice to make the cutter correct for the lowest number of teeth mentioned in the range which it covers. For instance a No. 2 Cutter which cuts from 55 to 134 teeth is made of the correct curve for 55 teeth. When the cutter is used for any number of teeth greater than 55, the teeth will be rounded over more than is actually necessary. Owing to this feature the length of bearing on the tooth decreases gradually with the increase in the number of teeth in gear and such gears will not run quite as smoothly and quietly as gears with teeth cut of the correct shape.

For general purposes the stock cutters have proved satisfactory but there is an increasing demand for gears with teeth cut as nearly as possible to the theoretically correct curve, thus securing a longer bearing and the very best results, as regards smooth action and quiet running. Such gears are particularly valuable for use on milling machines, lathes, planers, drills and kindred tools, and have been largely adopted.

Every facility is provided for producing cutters for such gears made of the correct curve for the exact number of teeth to be cut and their use as a means of improving the gearing feature of machine tools is recommended. These cutters are called single purpose cutters.

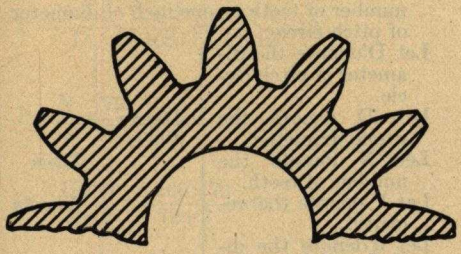
Prices for cutters quoted promptly on receipt of data as to pitch, number of teeth and sizes required.

UNION INVOLUTE GEAR CUTTERS

1919 REVISION

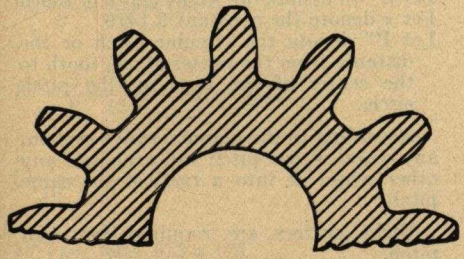
INVOLUTE TEETH OF INCREASED STRENGTH

12 TEETH, 14½° PRESSURE ANGLE



Mechanics whose studies or labors have been along the line of gearing are familiar with the fact that for a great many years it has been an almost universal custom to make involute gears with a form of tooth designed for 14½ degree pressure angle. Departures have been made from this rule, however, in individual cases where the demands have been for a stronger tooth. This demand arises more particularly in the case of small pinions having few teeth and which are to perform heavy service. One method of increasing the strength of teeth in such pinions is to adopt gearing of a greater pressure angle. Gears running together must be made according to the same system.

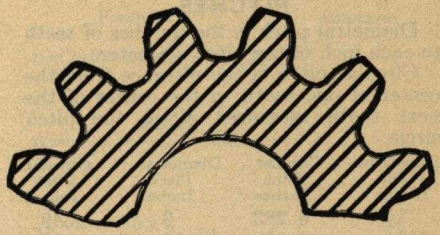
12 TEETH, 20° PRESSURE ANGLE



In the pinions of 14½ degree pressure angle the construction is such that the flanks of the teeth are radial for a certain distance inside the pitch circle. This naturally weakens the tooth, as it is thinner at the root than at the pitch circle, and consequently stronger than the pinions of 14½ degree pressure angle.

STUB TOOTH CUTTERS

12 TEETH, 20° PRESSURE ANGLE
STUB TOOTH



It is possible to select different pressure angles, although 32 degrees is about the limit if the regular strength of tooth is to be maintained.

Special cutters of high speed or carbon steel for cutting gears with stub teeth can be furnished.

These cutters are usually made with 20 degree pressure angle and to cut the different ranges of teeth. They can also be made of exact shape for any given number of teeth.

As a Stub Tooth Gear Cutter of 4-P. is usually made to cut a tooth of the same depth as a regular 5-P. tooth, the cutter is designated as a ⅘-P. Cutter.

The following table gives the tooth dimensions of the most commonly used pitches:

Pitch	Thickness on Pitch Line	Working Depth of Tooth
4/5	.3925	.4000
5/7	.3140	.2858
6/8	.2617	.2500
7/9	.2243	.2220
8/10	.1962	.2000
9/11	.1744	.1818
10/12	.1570	.1666
12/14	.1308	.1428

The above sketch represents a 12-tooth pinion 6 pitch, 8 pitch depth, 20 degree pressure angle.

In ordering state pressure angle, pitch, and number of teeth to be cut. Also state if range cutter or Single Purpose Cutter for a given number of teeth is wanted.

The greater the pressure angle the more the V shaped the tooth, and we think that 20° is perhaps the most suitable when sufficient reasons exist for making any change. We can furnish Cutter of any pressure angle. Prices on application.

TABLE SHOWING THE CORRESPONDING DIAMETRAL AND CIRCULAR PITCHES

1919 REVISION

TABLE SHOWING THE DIAMETRAL PITCHES WITH THE CORESPONDING CIRCULAR PITCHES

Diametral pitch is the number of teeth to each inch of the pitch diameter.

Circular pitch is the distance from the center of one tooth to the center of the next tooth measured along the pitch circle.

Diametral Pitch Inches	Circular Pitch Inches	Diametral Pitch Inches	Circular Pitch Inches
½	6.283	9	.349
¾	4.188	10	.314
1	3.141	11	.286
1¼	2.513	12	.262
1½	2.094	14	.224
1¾	1.795	16	.196
2	1.571	18	.175
2¼	1.396	20	.157
2½	1.257	22	.143
2¾	1.142	24	.131
3	1.047	26	.121
3½	.898	28	.112
4	.785	30	.105
5	.628	32	.098
6	.524	36	.087
7	.449	40	.079
8	.393	48	.065

TABLE SHOWING THE CIRCULAR PITCHES WITH THE CORESPONDING DIAMETRAL PITCHES

Circular Pitch Inches	Diametral Pitch Inches	Circular Pitch Inches	Diametral Pitch Inches
6	.523	1⅛	2.793
5	.628	1 1/16	2.957
4	.785	1	3.142
3½	.897	15/16	3.351
3	1.047	⅞	3.590
2¾	1.142	13/16	3.867
2½	1.256	¾	4.189
2¼	1.396	11/16	4.570
2	1.571	⅝	5.027
1⅞	1.676	9/16	5.585
1¾	1.795	½	6.283
1⅝	1.933	7/16	7.181
1½	2.094	⅜	8.378
1 7/16	2.185	5/16	10.053
1⅜	2.285	¼	12.566
1 5/16	2.394	3/16	16.755
1¼	2.513	⅛	25.133
1 3/16	2.646	1/16	50.266

FORMULAS FOR DETERMINING THE DIMENSIONS OF GEARS BY DIAMETRAL PITCH

Let P denote the diametral pitch, or the number of teeth to one inch of diameter of pitch circle.

Let D′ denote the diameter of pitch circle. (Larger Wheel)

Let D denote the whole diameter. (Larger Wheel)

Let N denote the number of teeth. (Larger Wheel)

Let V denote the velocity. (Larger Wheel)

Let d′ denote the diameter of pitch circle. (Smaller Wheel)

Let d denote the whole diameter. (Smaller Wheel)

Let n denote the number of teeth. (Smaller Wheel)

Let v denote the velocity. (Smaller Wheel)

These Wheels run together

Let a denote the distance between the centers of the two wheels.

Let b denote the number of teeth in both wheels.

Let t denote the thickness of tooth or cutter on pitch circle.

Let D″ denote the working depth of tooth.

Let f denote the amount added to depth of tooth for rounding the corners and for clearance.

Let D″+f denote the whole depth of tooth

Let π denote the constant 3.1416.

Let P″ denote the circular pitch or the distance from the center of one tooth to the center of the next on the pitch circle.

According to the manufacture's system, any wheel of one pitch will gear into any other wheel or into a rack of the same pitch.

Eight cutters are required for each pitch.

These eight cutters are adapted to cut from a pinion of twelve teeth to a rack, and are numbered respectively 1, 2, 3, etc.

The number of teeth and the pitch for which a cutter is adapted are also marked on each.

UNION MILLING CUTTERS

1919 REVISION

FORMULAS AND EXAMPLES

FOR A SINGLE WHEEL

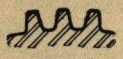
Formulas	Examples
$P=\frac{N+2}{D}=\frac{72+2}{6.166}$, or $\frac{72+2}{62-12}=12$	
$P=\frac{N}{D'}=\frac{72}{6}=12.$	
$D'=\frac{D\times N}{N+2}=\frac{6.166\times 72}{72+2}=6.$	
$D=\frac{N}{P}=\frac{72}{12}=6.$	
$N=PD'=12\times 6=72.$	
$N=PD-2=12\times 6.166-2$, or $12\times 62-12-2=72$	
$D=\frac{N+2}{P}=\frac{72+2}{12}=6.166$, or 62–12.	
$D=D'+\frac{2}{P}=6+\frac{2}{12}$, or $6+.166=6.166.$	
$t=\frac{1.57}{P}=\frac{1.57}{12}=.130.$	
$D''=\frac{2}{P}=\frac{2}{12}=-.166$ or 2–12.	
$f=\frac{t}{10}=\frac{.130}{10}=.013.$	
$D''+f=.166+.013=.179.$	
$P'=\frac{\pi}{P}=\frac{3.1416}{12}=.262.$	
$P=\frac{\pi}{P'}=\frac{3.1416}{.262}=12.$	

FOR A PAIR OF WHEELS

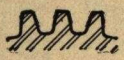
Formulas	Examples
$b=2aP=2\times 4.5\times 12=108.$	
$n=\frac{bV}{v+V}=\frac{108\times 1}{3}=36.$	
$N=\frac{nv}{V}=\frac{36\times 2}{1}=72.$	
$n=\frac{NV}{v}=\frac{72\times 1}{2}=36.$	
$N=\frac{bV}{v+V}=\frac{108\times 2}{3}=72.$	
$n=\frac{PD'V}{v}=\frac{12\times 6\times 1}{2}=36.$	
$D=\frac{2a\,(N+2)}{b}=\frac{2\times 4.5\,(72+2)}{108}=6.166.$	
$d=\frac{2a\,(n+2)}{b}=\frac{2\times 4.5\times (36+2)}{108}=3.166.$	
$a=\frac{P}{2P}=\frac{108}{2\times 12}=4.5$	
$D'=\frac{2av}{v+V}=\frac{2\times 4.5\times 2}{3}=6.$	
$d=\frac{2aV}{v+V}=\frac{2\times 4.5\times 1}{3}=3.$	
$a=\frac{D'+d'}{2}=\frac{6+3}{2}=4.5.$	

COMPARATIVE SIZES OF GEAR TEETH-INVOLUTE

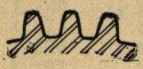
20 DIAMETRAL PITCH
.1571 INCH CIRCULAR PITCH



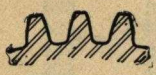
18 DIAMETRAL PITCH
.1745 INCH CIRCULAR PITCH



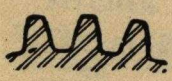
16 DIAMETRAL PITCH
.1963 INCH CIRCULAR PITCH



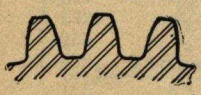
14 DIAMETRAL PITCH
.2244 INCH CIRCULAR PITCH



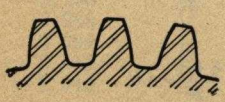
12 DIAMETRAL PITCH
.2618 INCH CIRCULAR PITCH



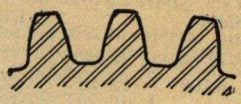
10 DIAMETRAL PITCH
3142 INCH CIRCULAR PITCH



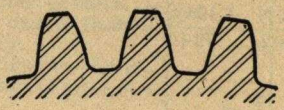
9 DIAMETRAL PITCH
3491 INCH CIRCULAR PITCH



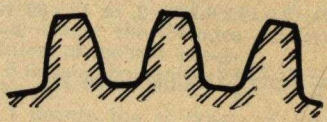
8 DIAMETRAL PITCH
.3927 INCH CIRCULAR PITCH



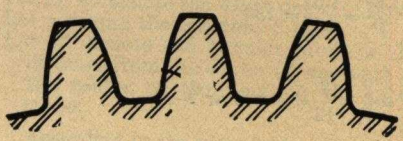
7 DIAMETRAL PITCH
.4488 INCH CIRCULAR PITCH



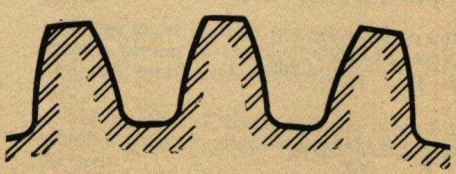
6 DIAMETRAL PITCH
.5236 INCH CIRCULAR PITCH



5 DIAMETRAL PITCH
.6283 INCH CIRCULAR PITCH



4 DIAMETRAL PITCH
.7854 INCH CIRCULAR PITCH



UNION HOBS

1919 REVISION

WORM HOBS

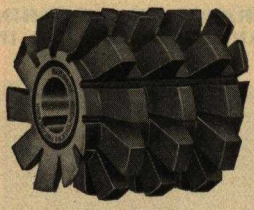


Fig. 14984A

Hobs may be furnished with relieved teeth. This admits of sharpening by grinding the faces of the teeth. Hobs are made larger diameter than the worm to provide for cutting the clearance at bottoms of teeth in worm wheel, and in addition a further slight increase so that a moderate amount of grinding will not reduce the diameter to less than that of the worm.

If the work to be performed requires a hob of exact diameter without the allowance above mentioned, please advise, as otherwise allowance would be made. In ordering give number of teeth in worm wheel, diameter of worm, size of hole in hob, dimensions of keyways. Lead or number of threads to one inch, single or double threads etc., right or left-hand.

Prices quoted upon application.

GENERATING HOBS FOR THE TEETH OF SPUR GEARS

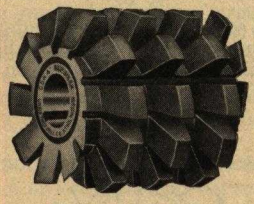


Fig. 14984B

These hobs are made of either carbon or high speed steel for any hobbing machine.

In ordering, give make of machine on which hobs are to be used, pitch, diameter, length, and whether carbon or high speed steel.

High speed steel is recommended for use.

For hobs ground, prices quoted upon application.

SPUR GEAR HOBS

FOR GOULD & EBERHART MACHINES

Diam. Pitch	Outside Diam. Inches	Length Inches	Diam. of Hole	Size Keyway Inches	High Speed Steel Price Each
1	10 1/4	15	2 1/2	5/8 x 5/16	727.00
1 1/4	8 1/4	12	2	1/2 x 1/4	419.20
1 1/2	7 1/2	10	2	1/2 x 1/4	304.10
1 3/4	7 1/4	9	2	1/2 x 1/4	260.70
2	5 3/4	8	1 1/2	3/8 x 3/16	168.65
2 1/4	5 1/4	7 1/2	1 1/2	3/8 x 3/16	140.50
2 1/2	5	7	1 1/2	3/8 x 3/16	123.20
2 3/4	4 3/4	6 1/2	1 1/2	3/8 x 3/16	107.35
3	4 1/2	6	1 1/2	3/8 x 3/16	92.80
3 1/2	4 1/8	5 1/2	1 1/4	3/16 x 3/32	76.65
4	3 7/8	5	1 1/4	3/16 x 3/32	64.85
5	3 1/2	4 1/2	1 1/4	3/16 x 3/32	52.10
6	3 1/4	4	1 1/4	3/16 x 3/32	42.80
7	3	3 1/2	1 1/4	3/16 x 3/32	34.40
8	2 7/8	3 1/2	1 1/4	3/16 x 3/32	33.20
9	2 3/4	3 1/4	1 1/4	3/16 x 3/32	29.50
10	2 3/4	3 1/4	1 1/4	3/16 x 3/32	29.50
11	2 5/8	3	1 1/4	3/16 x 3/32	28.35
12	2 1/2	3	1 1/4	3/16 x 3/32	28.05
14	2 1/2	3	1 1/4	3/16 x 3/32	28.40
16	2 1/2	2 1/2	1 1/4	3/16 x 3/32	26.65
18	2 3/8	2 1/2	1 1/4	3/16 x 3/32	26.40

FOR SCHUCHARDT & SCHUTTE MACHINES

Diam. Inches	Outside Diam. Ins.	Length Inches	Diam. Hole Inches	Size Keyway Inches	High Speed Steel Price Each
1 1/4	8	11 3/4	2 1/16	.320x.200	392.10
1 1/2	7 1/4	10 1/4	1 3/4	.280x.160	296.90
1 3/4	6 3/8	8 7/8	1 3/4	.280x.160	215.00
2	5 3/4	8	1 1/2	.280x.160	168.65
2 1/4	5 1/4	7 5/8	1 1/2	.280x.160	142.85
2 1/2	5	7	1 1/2	.280x.160	123.20
2 3/4	4 1/2	6 3/4	1 1/4	.200x.120	104.40
3	4 3/8	6	1 1/4	.200x.120	89.70
3 1/2	4	5 3/4	1 1/4	.200x.120	76.35
4	3 5/8	5 1/8	1 1/16	.200x.120	61.70
5	3 3/8	4 1/2	1 1/16	.200x.120	50.10
6	3	4	1 1/16	.200x.120	39.35
7	2 5/8	3 5/8	7/8	.160x.08	31.95
8	2 1/2	3 1/4	7/8	.160x.08	28.65
9	2 1/2	3 1/4	7/8	.160x.08	28.65
10	2 3/8	3	7/8	.160x.08	27.20
11	2 1/4	2 1/2	7/8	.160x.08	24.80
12	2 1/4	2 1/2	7/8	.160x.08	24.95
14	2 1/8	2 1/8	7/8	.160x.08	23.05
16	1 7/8	2 1/8	3/4	.160x.08	22.20
18	1 7/8	2 1/8	3/4	.160x.08	22.45
20	1 5/8	1 7/8	3/4	.160x.08	20.25

For above hobs ground prices upon application.

GROUND HOBS

1919 REVISION

GROUND HOBS

Ground Hobs, that is, hobs with teeth ground to form to eliminate errors which occur in hardening, are a departure which is making it possible to use the high productive possibilities and, at the same time, produce gears which more closely approach the accuracy and quiet running so essential in many instances.

It is only when these two points, especially the latter one, are to be considered particularly, that we would recommend using ground hobs.

Other conveniences are, all teeth being alike, the hob can be set up in machine without reference to any particular tooth. The advantage of this will at once be apparent. It also effects economy inasmuch as it can be moved along successively until the entire length of the hob is dull. Then, after grinding the faces of the teeth, the operation may be repeated.

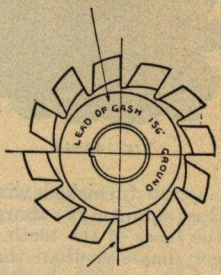
It should be remembered that the hobbing machine must be in the best possible condition and accurately adjusted, as any end play in the spindle, arbors running out of true, or other defects which may appear with the wear of machines being present, the advantages of the ground hob are depreciated to a great extent.

ORDERING HOBS

In ordering hobs the following data should be given: The outside diameter and length of the worm, the lead, that is, the advance to one turn, whether the thread is single, double, etc., right or left-hand, diameter of hole, size of keyway, material to be cut, whether hob is to be made of carbon or high speed steel, the method of cutting the worm, also state number of teeth in the wheel and whether it is driven by the hob when hobbing or by the hobbing machine spindle.

If the nature of the work requires a hob of exact diameter, it should be plainly stated when ordering, otherwise the allowance mentioned above will be added.

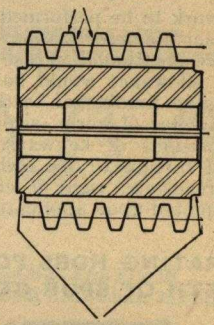
DIAGRAM GIVING GRINDING AND SETTING UP INSTRUCTIONS



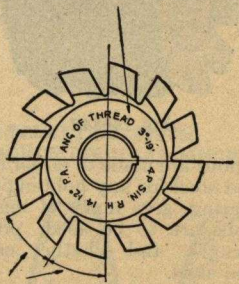
When sharpening, grind with lead of gash specified on end of hob.

Face of teeth must be radial, otherwise hob will not cut correct shape.

Teeth ground on top and sides.



When setting up it should be determined if hob runs true by placing indicator on hubs which are ground true with teeth.



When cutting spur gears swing hob angle of thread specified on end of hob.

Flutes must be equally spaced, otherwise hob will not run true.

UNION FORMED CUTTERS

1919 REVISION

IRREGULAR SHAPES PRODUCED BY FORMED CUTTERS

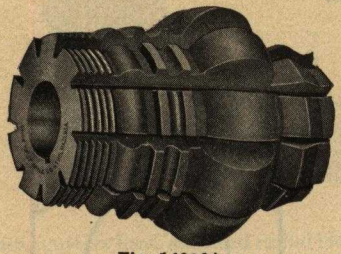
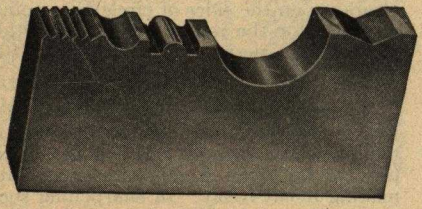


Fig. 14986A

Formed cutters are cutters which can be sharpened by grinding without changing their form. In producing duplicate or interchangeable parts, the formed cutter is economical, as each piece milled is a duplicate of every other piece.



Cutters of this type can be made singly or in combination to any outline. The same shape is maintained, until the cutter is entirely worn away. Formed cutters can be made for milling large or small parts, and can often be used to advantage in connection with profile cutters.

Prices quoted on formed cutters of carbon or high speed steel to any dimensions or outline upon application.

SUGGESTIONS IN ORDERING

When ordering formed cutters, perhaps the following remarks will be helpful as they cover important points.

In ordering, always send a drawing with all dimensions given and indicate the direction of revolution of cutter, that is whether bottom is "going" or "coming." Also send a templet if possible.

It is necessary to know under what conditions and on what material a cutter is to be used. Having such knowledge, it is possible in many cases to better adapt the cutter for that particular use, than if it were made to suit general conditions.

FIG. 1

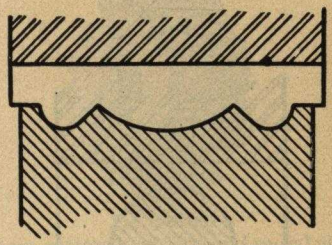


Figure 1 shows a cutter which extends beyond the work on both sides. It is not important that the cutter should be the exact thickness of the work, in fact it is desirable to have it overlap as sketch shows, yet definite advice should be given.

FIG. 2

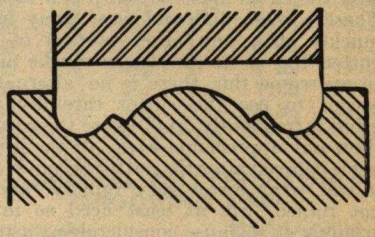


Figure 2 shows a cutter which is not so wide as the work, and mills only the central portion. In this case the total width of cutter is important. The form should be made in the center of the cutter and order should state as to how many thousandths can be allowed over or under the exact width of cut.

SUGGESTIONS IN ORDERING

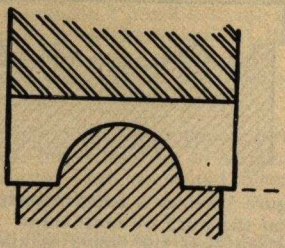
In the absence of instructions, the manufacturer must delay the order to make inquiries or assume that their ideas of the requirements are correct. The manufacturer should not be left to assume, as it is possible that the indications might be such as would lead them to put the same amount of work on Fig. 1 as on Fig. 2, whereas it would not be necessary. On the other hand, the manufacturer might, without knowing all the conditions, assume that the limits on Fig. 2 were unimportant, and neglect to make the form central, and might allow too wide a variation in the width.

UNION FORMED CUTTERS

CONTINUED

1919 REVISION

FIG. 3



Figures 3 and 4 will illustrate other points. Figure 3 is a concave cutter for milling a half circle and the inside corners next the circle must be sharp and square. These corners dull and wear away more quickly than any other portion of the cutter, but as no provisions can be made to overcome this there is no alternative except to use the cutter carefully and grind it frequently, and before the corners show any appreciable wear. If the grinding is delayed after the cutter becomes dull it will wear away very rapidly, and if not ruined, will at least need so much grinding as to cause considerable waste.

FIG. 4

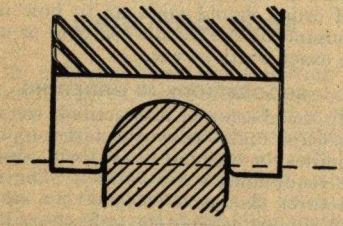


Fig. 4 is a concave cutter which cuts somewhat deeper than a half circle. In this case the sharp corner as in Fig. 3 is not necessary, as it can be rounded slightly as shown. This saves the cutter to a great extent as the rounding corner will not dull so quickly and consequently adds to the life of the cutter.

FIG. 5

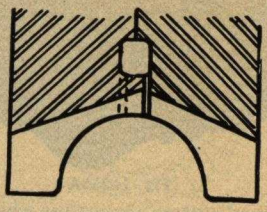


Figure 5 is a concave cutter made in two parts interlocked at the center. It is generally understood that a concave cutter particularly when it cuts deeper than the half circle, has little or no cutting clearance on the sides of circle near points of teeth, for the reason that this portion is so nearly perpendicular to the cutter arbor.

Where the nature of the work will permit, it is of advantage to make cutter in two parts as shown, as this will allow each part to be given a side clearance, thus making it cut freely. In sharpening such cutters the total width of the circle milled will be increased slightly on account of the side clearance, but cutters can be readily adjusted to the original or true width of circle by simply reducing the packing between cutters the required amount.

These are only a few instances, but will serve to illustrate some of the questions which arise when an order is not definite.

In many cases, it is possible to save much delay and expense by giving careful consideration to the requirements and the instructions concerning same in the order.

The economy and usefulness of formed cutters is well shown in the illustrations on the following page, which were taken from cutters in actual use. The end views show how repeated sharpening has reduced the length of the teeth. The cutters are now practically worn out, as the teeth are so thin that further grinding would tend to weaken them to such an extent that they would not withstand the cutting strain.

UNION CIRCULAR CORNERING CUTTERS

1919 REVISION

LEFT-HAND SINGLE

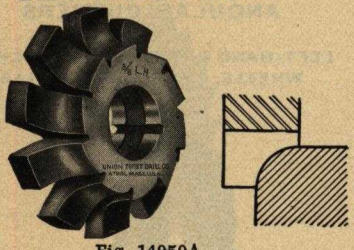


Fig. 14950A

These cutters have side and radial clearance, and can be sharpened by grinding without changing their form.

In ordering, state whether right or left-hand is wanted.

No.	Radius of Circle Inches	Diam. of Cutter Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
D41	1/16	2	7/8	2.45	3.70
D43	1/8	2	7/8	3.20	4.85
D45	3/16	2 1/4	7/8	3.45	5.25
D47	1/4	2 1/4	7/8	3.80	5.70
D48	5/16	2 3/4	1	4.65	7.00
D49	3/8	3	1	5.25	8.00
D50	7/16	3 1/4	1	6.20	9.35
D51	1/2	3 1/4	1	6 45	9.75
D53	5/8	3 1/2	1	7.70	11.70

RIGHT-HAND SINGLE

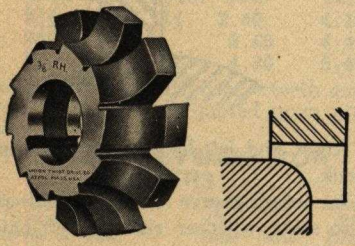


Fig. 14950B

No.	Radius of Circle Inches	Diam. of Cutter Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
D61	1/16	2	7/8	2.45	3.70
D63	1/8	2	7/8	3.20	4.85
D65	3/16	2 1/4	7/8	3.45	5.25
D67	1/4	2 1/4	7/8	3.80	5.70
D68	5/16	2 3/4	1	4.65	7.00
D69	3/8	3	1	5.25	8.00
D70	7/16	3 1/4	1	6.20	9.35
D71	1/2	3 1/4	1	6.45	9.75
D73	5/8	3 1/2	17	.70	11.70

RIGHT AND LEFT-HAND DOUBLE

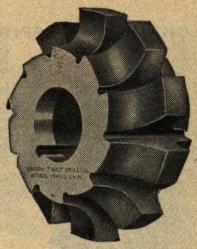


Fig. 14950C

These cutters have side and radial clearance, and can be sharpened without changing their form.

No.	Radius of Circle Inches	Diam. of Cutter Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
D81	1/16	2	7/8	3.10	4.75
D83	1/8	2	7/8	3.35	5.00
D85	3/16	2 1/4	7/8	3.90	5.85
D87	1/4	2 1/4	7/8	4.25	6.40
D88	5/16	2 3/4	1	5.35	8.10
D89	3/8	3	1	6.40	9.70
D90	7/16	3 1/4	1	7.25	11.00
D91	1/2	3 1/4	1	7.65	11.65
D93	5/8	3 1/2	1	8.85	13.45

Cutters varying from the above list made to order.

SPECIAL CUTTERS FOR GROOVING TAPS

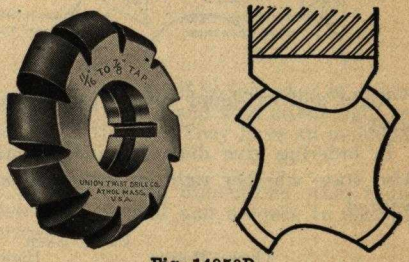


Fig. 14950D

No.	No. of Cutter	Diam. of Cutter Inches	Diam. of Tap Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
E30	1	2	0 to 1/8	1	2.10	3.15
E31	2	2	5/32 " 1/4	1	2.45	3.70
E32	3	2 1/8	9/32 " 3/8	1	3.35	5.10
E33	4	2 1/4	7/16 " 5/8	1	3.60	5.45
E34	5	2 3/8	11/16 " 7/8	1	4.15	6.30
E35	6	2 1/2	15/16 " 1 1/4	1	4.70	7.10
E36	7	2 5/8	1 5/16 " 1 5/8	1	5.85	8.85
E37	8	2 7/8	1 11/16 " 2	1	6.55	9.90
E38	9	3 1/8	2 1/16 " 2 7/16	1	8.10	12.25
E39	10	3 3/8	2 1/2 " 3	1	9.35	14.45

UNION CUTTERS

1919 REVISION

ANGULAR CUTTERS

LEFT-HAND CUTTERS FOR SPIRAL MILLS

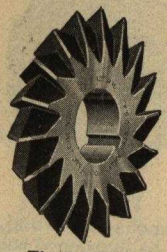
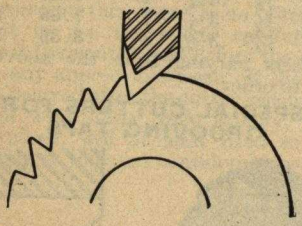


Fig. 14954 A

Cutters are carried in stock especially adapted to the cutting of spiral mills, either 53°, 48°, or 40° one side and 12° on the other. The 53° angle is recommended except for small and fine tooth cutters



Right and left-hand cutters carried in stock.

In ordering give diameter and angle. Also state whether right or left-hand is wanted.

No.	Diam. Inches	Thickness Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
F1	2½	½	⅞	3.40	4.10
F2	2¾	½	1	3.60	4.45
F3	3	½	1¼	4.30	5.40
*F4	3¼	½	1½	4.80	6.15

Above can also be furnished with coarse teeth and undercut teeth. Prices quoted upon application.

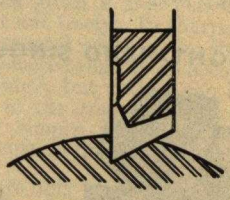
*This size furnished only with 53x12 degree angle.

ANGULAR CUTTERS

LEFT-HAND CUTTERS FOR RATCHET WHEELS, CUTTERS AND MILLS

Fig. 14954B

Cutters of 45°, 50°, 60°, 70°, and 80° angles, are carried in stock, suitable for cutting the teeth of ratchet wheels, cutters and mills.



Right and left-hand cutters carried in stock.

In ordering give diameter and angle. Also state whether right or left-hand is wanted.

No.	Diam. Inches	Thickness Inches	Hole in Cutter Inches	—Price, Each— Carbon Steel	—Price, Each— High Speed Steel
F5	2½	½	⅞	3.40	4.10
F6	2¾	½	1	3.60	4.45
F7	3	½	1¼	4.30	5.40

Above can also be furnished with coarse teeth and undercut teeth. Prices quoted upon application

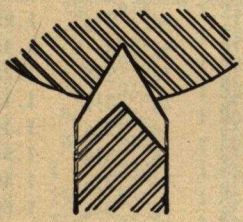
UNION ANGULAR CUTTERS

1919 REVISION

DOUBLE ANGLE CUTTERS

Fig. 14989A

This cutter is carried in stock, the angle being equal on each side of the center line and with the included angle either 45°, 60°, or 90°.



In ordering give diameter and angle.

No.	Diam. Inches	Thick-ness Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
F10	2½	½	⅞	3.40	4.10
F11	2¾	½	1	3.60	4.45
F12	3	½	1¼	4.30	5.40

Can be furnished with coarse teeth and undercut teeth. Prices quoted upon application.

STANDARD KEYWAYS FOR CUTTERS

Diameter of Hole (D) in Cutter Inches or MM.		Width (W) Inches	Depth (A) Inches	Radius (R) Inches
⅜ to 9/16	.....	3/32	3/64	.020
5/8 " 7/8	16 to 21	1/8	1/16	.030
15/16 " 1⅛	22 " 36	5/32	5/64	.035
1 3/16 " 1 3/8	27 " 31	3/16	3/32	.040
1 7/16 " 1¾	*32 " 37	¼	⅛	.050
1 13/16 " 2	38 " 44	5/16	5/32	.060
2 1/16 " 2½	45	⅜	3/16	.060
2 9/16 " 3	.....	7/16	3/16	.060

All gear cutters 1½, 1¾, and 2 inch holes have 5/16, ⅜, and ½-inch keyways, respectively, excepting those with 1½-inch hole which can also be furnished with ⅜-inch keyway.

ANGULAR CUTTERS WITH THREADED HOLES

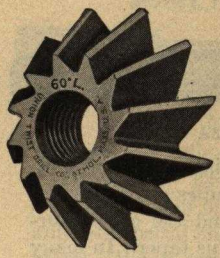
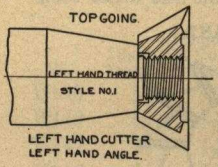
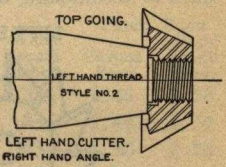
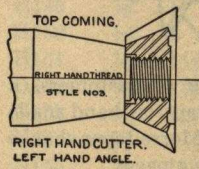


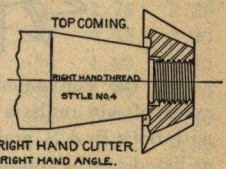
Fig. 14989B

Fig. 14989C









These cutters will be furnished in either right or left-hand and with either right or left-hand thread. They have an included angle of 60 degrees.

Cutters having dimensions other than listed are special and subject to special prices.

In ordering, give angle and style of cutter wanted.

No.	Diam. Inches	Thick-ness Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
F20	1¼	7/16	⅜	3.00	3.60
F21	1⅝	9/16	½	3.70	4.50
F22	4	1¼	1¼	10.50	15.00

Can be furnished with coarse teeth and under cut teeth. Prices quoted upon application.

UNION END MILLS

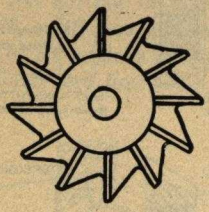
1919 REVISION

END MILLS

Fig.14973A

Nearly all the regular makes of milling machines have spindles provided with B. & S. taper holes and the collets furnished correspond to this taper. In many cases, however, special collets have been made with the inside taper of Morse Standard to accomodate drills and other tools

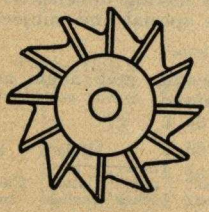
LEFT HAND



For the convenience of customers, a stock of end mills is kept on hand made with both B. & S. and Morse taper shanks as listed on the following pages.

High speed steel end mills, spiral cut, have a right-hand spiral on right-hand mills, and a left-hand spiral on left-hand mills.

RIGHT-HAND



All end mills, spiral cut, made to order carbon or high speed steel, have a right-hand spiral on right-hand mills, and left-hand spiral on left-hand mills, unless otherwise specified.

STRAIGHT CUT LEFT-HAND END MILLS

BROWN & SHARPE TAPER SHANKS

Fig. 14973B

Right and left-hand mills carried in stock. In ordering, state whether right or left-hand is wanted. Also give number of shank.

No.	Diam. Inches	Length of Cut Inches	Whole Length Inches	—Price, Each— Carbon Steel	High-Speed Steel
H 1	1/4	3/16	2 7/16	1.25	1.40
H 2	1/4	3/16	3	1.45	1.70
H 3	5/16	7/8	2 1/2	1.25	1.40
H 4	5/16	7/8	3 1/16	1.45	1.70
H 5	3/8	7/8	2 1/2	1.40	1.55
H 6	3/8	7/8	3 1/16	1.55	1.75
H 7	7/16	15/16	2 9/16	1.40	1.55
H 8	7/16	15/16	3 1/8	1.60	1.80
H 9	1/2	1	3 3/16	1.65	1.90
H10	1/2	1 1/8	5 1/8	1.80	2.40
H11	9/16	1 1/16	3 1/4	1.70	2.00
H12	9/16	1 1/4	5 1/4	2.00	2.50
H13	5/8	1 1/4	3 7/16	1.80	2.20
H14	5/8	1 1/2	5 1/2	2.15	2.80
H15	11/16	1 1/2	5 1/2	2.20	2.85
H17	3/4	1 5/8	5 5/8	2.25	2.95
H18	3/4	1 5/8	6 7/8	2.50	3.85
H21	7/8	1 3/4	5 3/4	2.65	3.55
H22	7/8	1 3/4	7	2.85	4.25
H25	1	1 7/8	5 7/8	2.70	3.80
H26	1	1 7/8	7 1/8	2.90	4.35
H29	1 1/8	2	6	2.85	4.20
H30	1 1/8	2	7 1/4	3.00	4.60
H33	1 1/4	2	6	2.85	4.45
H34	1 1/4	2	7 1/4	3.25	5.10
H36	1 3/8	2 1/8	7 3/8	3.45	6.25
H38	1 1/2	2 1/4	7 1/2	3.80	6.85

Can also be furnished with coarse teeth and undercut teeth. Prices upon application.

UNION END MILLS

1919 REVISION

SPIRAL CUT RIGHT-HAND MILLS

BROWN & SHARPE TAPER SHANKS

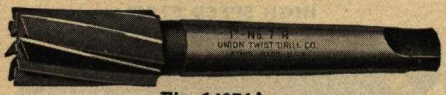


Fig. 14974A

Right and left-hand mills carried in stock. In ordering, state whether right or left-hand is wanted. Also give shank number.

No.	Diam. Inches	Length of Cut Inches	Whole Length Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
H50	1/4	13/16	2 7/16	1.25	1.40
H51	1/4	13/16	3	1.45	1.70
H52	5/16	7/8	2 1/2	1.25	1.40
H53	5/16	7/8	3 1/16	1.45	1.70
H54	3/8	7/8	2 1/2	1.40	1.55
H55	3/8	7/8	3 1/16	1.55	1.75
H56	7/16	15/16	2 9/16	1.40	1.55
H57	7/16	15/16	3 1/8	1.60	1.80
H58	1/2	1	3 3/16	1.65	1.90
H59	1/2	1 1/8	5 1/8	1.80	2.40
H60	9/16	1 1/16	3 1/4	1.70	2.00
H61	9/16	1 1/4	5 1/4	2.00	2.50
H62	5/8	1 1/4	3 7/16	1.80	2.20
H63	5/8	1 1/2	5 1/2	2.15	2.80
H64	11/16	1 1/2	5 1/2	2.20	2.85
H65	11/16	1 1/2	6 3/4	2.40	3.75
H66	3/4	1 5/8	5 5/8	2.25	2.95
H67	3/4	1 5/8	6 7/8	2.50	3.85
H70	7/8	1 3/4	5 3/4	2.65	3.55
H71	7/8	1 3/4	7	2.85	4.25
H74	1	1 7/8	5 7/8	2.70	3.80
H75	1	1 7/8	7 1/8	2.90	4.35
H78	1 1/8	2	6	2.85	4.20
H79	1 1/8	2	7 1/4	3.00	4.60
H82	1 1/4	2	6	2.85	4.45
H83	1 1/4	2	7 1/4	3.25	5.10
H85	1 3/8	2 1/8	7 3/8	3.45	6.25
H87	1 1/2	2 1/4	7 1/2	3.80	6.85
H88	1 5/8	2 3/8	7 5/8	4.15	7.45
H89	1 3/4	2 1/2	7 3/4	4.45	8.30

Above can be furnished with coarse teeth and undercut teeth. Prices quoted upon application.

SPIRAL CUT RIGHT-HAND END MILLS

MORSE TAPER SHANK

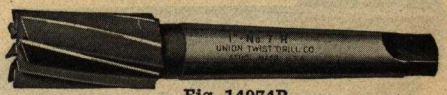


Fig. 14974B

These end mills are furnished regularly in right-hand. End mills having dimensions other than listed, and left-hand end mills are special and are subject to special prices. When ordering, give number of shank furnished with both right and left-hand spiral.

No.	Diam. Inches	Length of Cut Inches	Whole Length Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
H145	1/4	13/16	3 11/16	1.45	1.70
H146	5/16	7/8	3 3/4	1.45	1.70
H147	3/8	7/8	3 3/4	1.55	1.75
H148	7/16	15/16	3 13/16	1.60	1.85
H149	7/16	1	4 9/16	1.75	2.25
H150	1/2	1	3 15/16	1.65	1.90
H151	1/2	1 1/8	4 11/16	1.80	2.30
H152	9/16	1 1/16	3 15/16	1.70	2.00
H153	9/16	1 1/4	4 13/16	2.00	2.40
H154	5/8	1 1/2	5	2.00	2.50
H155	11/16	1 1/2	5	2.20	2.75
H156	3/4	1 5/8	5 1/8	2.25	2.85
H157	3/4	1 5/8	5 31/32	2.50	3.45
H160	7/8	1 3/4	5 1/4	2.65	3.40
H161	7/8	1 3/4	6 3/32	2.85	3.75
H164	1	1 7/8	5 3/8	2.70	3.60
H165	1	1 7/8	6 7/32	2.90	4.00
H168	1 1/8	2	6 11/32	3.00	4.25
H170	1 1/4	2	6 11/32	3.10	4.65
H171	1 1/4	2	7 11/32	3.25	5.00
H174	1 3/8	2 1/8	6 15/32	3.35	5.20
H175	1 3/8	2 1/8	7 15/32	3.45	5.60
H178	1 1/2	2 1/4	6 19/32	3.45	5.65
H179	1 1/2	2 1/4	7 19/32	3.80	6.25

Above can be furnished with coarse teeth and undercut teeth. Prices quoted upon application.

UNION END MILLS

1919 REVISION

STRAIGHT CUT END MILLS

MORSE TAPER SHANKS

Fig. 14959A

These end mills are furnished regularly in right-hand. End mills having dimensions other than listed, and left-hand end mills are special and subject to special prices.

In ordering give number of shank

No.	Diam. Inches	Length of Cut Inches	Whole Length Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
H100	1/4	13/16	3 11/16	1.45	1.70
H101	5/16	7/8	3 3/4	1.45	1.70
H102	3/8	7/8	3 3/4	1.55	1.75
H103	7/16	15/16	3 13/16	1.60	1.85
H104	7/16	1	4 9/16	1.75	2.25
H105	1/2	1	3 15/16	1.65	1.90
H106	1/2	1 1/8	4 11/16	1.80	2.30
H107	9/16	1 1/16	3 15/16	1.70	2.00
H108	9/16	1 1/4	4 13/16	2.00	2.40
H109	5/8	1 1/2	5	2.00	2.50
H110	11/16	1 1/2	5	2.20	2.75
H111	3/4	1 5/8	5 1/8	2.25	2.85
H112	3/4	1 5/8	5 21/32	2.50	3.45
H115	7/8	1 3/4	5 1/4	2.65	3.40
H116	7/8	1 3/4	6 3/32	2.85	3.75
H119	1	1 7/8	5 3/8	2.70	3.60
H120	1	1 7/8	6 7/32	2.90	4.00
H123	1 1/8	2	6 11/32	3.00	4.25
H125	1 1/4	2	6 11/32	3.10	4.65

Above can be furnished with coarse teeth and undercut teeth, Prices upon application.

ADVANTAGES OF COARSE TOOTH MILLING CUTTERS

The main advantage of coarse tooth milling cutters may be stated as increased production and decreased power consumption due to the heavier cuts taken and the freer cutting action. Of course, the amount of improvement in these points differs greatly in various instances owing to the conditions, such as the stiffness of the work, nature of the cut, strength of the machine, etc.

A marked advantage arising from the free cutting action is the consumption of less power, as might be expected from the fact that there is less friction and heating.

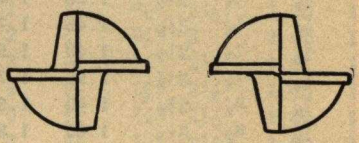
TWO-LIPPED SLOTTING END MILLS

HIGH SPEED STEEL BROWN AND SHARPE TAPER SHANK

Fig. 14959B

These end mills have been designed especially for rapid milling of slots in steel and iron from the solid.

LFFT-HAND RIGHT-HAND



In ordering specify whether right or left-hand is required. Also give number of shank.

Can be furnished with Morse Taper Shank when required.

No.	Diam. Inches	Length of Cut Inches	Whole Length Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
H300	1/4	3/8	2	1.25	1.40
H301	1/4	3/8	2 1/2	1.45	1.70
H302	1/4	3/8	4 3/8	1.70	2.00
H303	5/16	15/32	2 19/32	1.45	1.70
H304	5/16	15/32	4 15/32	1.75	2.10
H305	3/8	9/16	4 9/16	1.80	2.15
H306	7/16	21/32	4 21/32	1.80	2.25
H307	1/2	3/4	4 3/4	1.80	2.40
H308	9/16	27/32	4 27/32	2.00	2.50
H309	5/8	15/16	4 15/16	2.15	2.80
H310	11/16	1 1/32	5 1/32	2.20	2.85
H311	3/4	1 1/8	5 1/8	2.25	2.95
H313	13/16	1 7/32	5 7/32	2.40	3.35
H315	7/8	1 7/32	5 15/16	2.65	3.55
H316	7/8	1 5/16	6 9/16	2.85	4.25
H317	15/16	1 13/32	6 21/32	2.65	4.25
H318	1	1 1/2	6 3/4	2.90	4.35
H320	1 1/8	1 11/16	6 15/16	3.00	4.60
H322	1 1/4	1 7/8	7 1/8	3.25	5.10
H324	1 3/8	2 1/16	7 5/16	3.45	6.25
H326	1 1/2	2 1/4	7 1/2	3.80	6.85

UNION CUTTERS

1919 REVISION

WOODRUFF KEYWAY CUTTERS

½-INCH SHANK

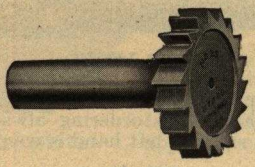


Fig. 14980A

All cutters right-hand unless otherwise specified.

No.	Diam. Inches	Thickness Inches	Shank Inches	Price, Each' Carbon Steel	High Speed Steel
1	1/2	1/16	1/2	1.20	....
2	1/2	3/32	1/2	1.20	....
3	1/2	1/8	1/2	1.20	1.20
4	5/8	3/32	1/2	1.40	1.40
5	5/8	1/8	1/2	1.40	1.40
6	5/8	5/32	1/2	1.40	1.40
7	3/4	1/8	1/2	1.55	1.60
8	3/4	5/32	1/2	1.55	1.60
9	3/4	3/16	1/2	1.55	1.60
10	7/8	5/32	1/2	1.75	1.95
11	7/8	3/16	1/2	1.75	1.95
12	7/8	7/32	1/2	1.75	1.95
A	7/8	1/4	1/2	1.75	1.95
13	1	3/16	1/2	2.00	2.35
14	1	7/32	1/2	2.00	2.35
15	1	1/4	1/2	2.00	2.35
B	1	5/16	1/2	2.00	2.35
16	1 1/8	3/16	1/2	2.20	2.75
17	1 1/8	7/32	1/2	2.20	2.75
18	1 1/8	1/4	1/2	2.20	2.75
C	1 1/8	5/16	1/2	2.20	2.75
19	1 1/4	3/16	1/2	2.40	3.20
20	1 1/4	7/32	1/2	2.40	3.20
21	1 1/4	1/4	1/2	2.40	3.20
D	1 1/4	5/16	1/2	2.40	3.20
E	1 1/4	3/8	1/2	2.40	3.20
22	1 3/8	1/4	1/2	2.70	3.80
23	1 3/8	5/16	1/2	2.70	3.80
F	1 3/8	3/8	1/2	2.70	3.80
24	1 1/2	1/4	1/2	2.70	3.95
25	1 1/2	5/16	1/2	2.70	3.95
G	1 1/2	3/8	1/2	2.70	3.95

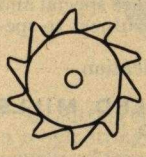
Not made in high speed steel.

STANDARD T SLOT CUTTERS

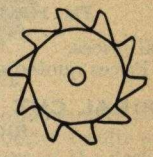
BROWN & SHARPE TAPER SHANKS
LEFT-HAND

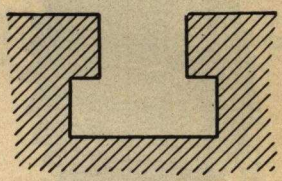
Fig. 14980B

LEFT-HAND CUTTER



RIGHT-HAND CUTTER





These cutters are commonly used for cutting the slots in milling machine tables or work of similar character.

They are made $\frac{1}{32}$ inch larger in diameter and $\frac{1}{64}$ inch thicker than figures given to allow for sharpening.

Right and left-hand cutters carried in stock. In ordering, state whether right or left hand is wanted. Also give number of cutter.

No.	Diam. Cutter Inches	Thickness Cutter Inches	Diam. of Neck of Cutter Inches	Price, Each Carbon Steel	High Speed Steel
4	1/2	5/32	7/32	2.00	2.10
7	1/2	5/32	7/32	2.10	2.25
10	5/8	5/32	9/32	2.20	2.60
13	5/8	5/32	9/32	2.65	3.25
16	11/16	7/32	11/32	2.55	2.90
19	11/16	7/32	11/32	2.80	3.35
22	13/16	7/32	3/8	3.00	3.65
28	15/16	9/32	7/16	3.30	4.15
31	15/16	9/32	7/16	3.50	4.80
34	1 3/16	13/32	17/32	3.90	5.55
37	1 5/16	17/32	21/32	4.35	6.35
40	1 5/8	11/16	25/32	4.75	7.75

UNION END MILLS

1919 REVISION

STRAIGHT CUT SHELL END MILLS

RIGHT-HAND

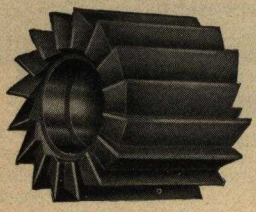


Fig. 14958A

These mills are designed to do work larger than that for which the regular types of end mills are suited.

Straight cut end mills are special and subject to special prices.

Prices quoted upon application.

SPIRAL CUT SHELL END MILLS

RIGHT-HAND

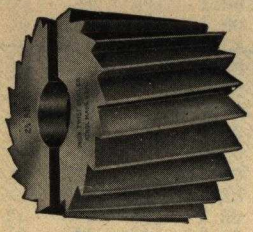


Fig. 14958B

Furnished with both right and left-hand spiral.

No.	Diam. Inches	Length of Cut Inches	Hole in Cutter Inches	Price, Each Carbon Steel	Price, Each High Speed Steel
L50	1 1/4	1 1/4	1/2	3.90	4.50
L51	1 5/16	1 1/4	1/2	4.00	4.55
L52	1 3/8	1 1/4	1/2	4.00	4.60
L53	1 7/16	1 1/4	1/2	4.10	4.70
L54	1 1/2	1 1/4	1/2	4.10	4.80
L55	1 9/16	1 3/4	3/4	5.00	6.00
L56	1 5/8	1 3/4	3/4	5.00	6.15
L57	1 11/16	1 3/4	3/4	5.15	6.30
L58	1 3/4	1 3/4	3/4	5.15	6.45
L59	1 13/16	1 3/4	3/4	5.30	6.60
L60	1 7/8	1 3/4	3/4	5.30	6.70
L61	1 15/16	1 3/4	3/4	5.45	6.85
L62	2	1 3/4	3/4	5.45	7.05
L64	2 1/8	1 3/4	3/4	5.60	7.25
L66	2 1/4	2 1/4	1	6.20	8.55
L68	2 3/8	2 1/4	1	6.35	8.85
L70	2 1/2	2 1/4	1	6.50	9.15
L72	2 5/8	2 1/4	1	6.80	9.75
L74	2 3/4	2 1/4	1	7.15	10.40
L76	2 7/8	2 1/4	1	7.55	11.00
L78	3	2 1/4	1	8.00	11.75

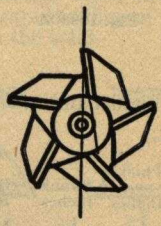
HIGH SPEED STEEL END MILLS

SPIRAL CUT

BROWN & SHARPE TAPER SHANKS

Fig. 14958C

High power type, undercut teeth, right or left hand. In ordering always state whether right or left hand is wanted.



No.	Diam. Inches	No. of Taper	Length of Cut Inches	Whole Length Inches	Price, Each High Speed Steel
H1599	3/8	4	7/8	2 1/2	1.55
H1600	3/8	5	7/8	3 1/16	1.75
H1600 1/4	7/16	4	15/16	2 9/16	1.55
H1601	7/16	5	15/16	3 1/8	1.80
H1602	1/2	5	1	3 3/16	1.90
H1603	1/2	7	1 1/8	5 1/8	2.40
H1605	9/16	7	1 1/4	5 1/4	2.50
H1606	5/8	5	1 1/4	3 7/16	2.20
H1607	5/8	7	1 1/2	5 1/2	2.80
H1608	11/16	7	1 1/2	5 1/2	2.85
H1610	3/4	7	1 5/8	5 5/8	2.95
H1611	3/4	9	1 5/8	6 7/8	3.85
H1614	7/8	7	1 3/4	5 3/4	3.55
H1615	7/8	9	1 3/4	7	4.25
H1618	1	7	1 7/8	5 7/8	3.80
H1619	1	9	1 7/8	7 1/8	4.35
H1622	1 1/8	7	2	6	4.20
H1623	1 1/8	9	2	7 1/4	4.60
H1625	1 3/16	9	2	7 1/4	4.90
H1626	1 1/4	7	2	6	4.45
H1627	1 1/4	9	2	7 1/4	5.10
H1628	1 1/4	10	2 1/4	9 1/2	5.80
H1629	1 3/8	9	2 1/8	7 3/8	6.25
H1630	1 3/8	10	2 1/4	9 1/2	6.75
H1631	1 1/2	9	2 1/4	7 1/2	6.85
H1632	1 1/2	10	2 1/2	9 3/4	7.80
H1633	1 5/8	9	2 3/8	7 5/8	7.45
H1634	1 5/8	10	2 1/2	9 3/4	8.50
H1635	1 3/4	9	2 1/2	7 3/4	8.30
H1636	1 3/4	10	2 3/4	10	9.25
H1637	2	10	2 3/4	10	10.50

UNION METAL SLITTING SAWS

1919 REVISION

Fig. 14957A

METAL SLITTING SAWS

CONCAVE SIDES

Can also be furnished with coarse teeth and undercut teeth. Prices upon application.

No.	Diam. Inches	Thickness Inches	Hole in Cutter Inches	—Price, Each— Carbon Steel	High Speed Steel
M 1	2½	1/32	7/8	1.30	2.50
M 3	2½	3/64	7/8	1.20	2.40
M 5	2½	1/16	7/8	1.15	2.35
M 7	2½	3/32	7/8	1.15	2.35
M 9	2½	1/8	7/8	1.15	2.35
M11	2½	5/32	7/8	1.40	2.60
M13	3	1/32	1	1.60	2.95
M15	3	3/64	1	1.45	2.60
M17	3	1/16	1	1.30	2.50
M19	3	3/32	1	1.30	2.50
M21	3	1/8	1	1.30	2.50
M23	3	5/32	1	1.50	2.85
M25	4	1/32	1	2.85	4.60
M27	4	3/64	1	1.85	3.15
M29	4	1/16	1	1.60	2.95
M31	4	3/32	1	1.55	2.85
M33	4	1/8	1	1.55	2.85
M35	4	5/32	1	1.80	3.45
M37	4	3/16	1	2.10	3.45
M39	5	1/16	1	2.30	3.85
M41	5	3/32	1	2.00	3.35
M43	5	1/8	1	2.00	3.35
M45	5	1/8	1¼	2.00	3.35
M47	5	1/8	1½	2.00	3.35
M49	5	5/32	1	2.45	4.30
M51	5	3/16	1	2.90	4.30
M53	6	1/16	1	5.10	7.50
M55	6	3/32	1	3.85	5.85
M57	6	1/8	1	3.45	5.35
M57¼	6	1/8	1¼	3.45	6.45
M59	6	3/16	1	4.45	6.45
M61	6	3/16	1½	4.45	11.00
M65	7	1/16	1	9.50	11.00
M67	7	5/32	1	5.70	8.35
M69	7	1/8	1	4.85	7.20
M69¼	7	3/16	1¼	6.50	9.05
M69½	7	3/16	2	6.50	9.05
M70	8	1/8	1	7.30	12.00
M71	8	1/8	1¼	7.30	12.00
M73	8	3/16	1¼	8.90	17.30
M75	8	3/16	1½	8.90	12.30

SPECIAL FORMED METAL SLITTING SAWS FOR USE ON COPPER

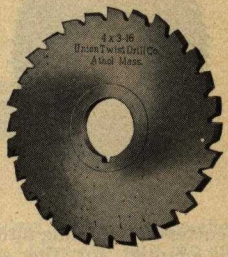
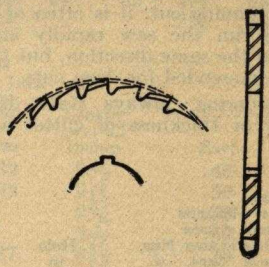


Fig. 14957B

In cutting copper and other materials of a rough stringy nature, better results are usually obtained with saws of the design shown. The teeth are so constructed as to break up and throw out the chips and prevent to a great extent the clogging of the saw.



The sides of saw are ground concave for clearance. The teeth are given a good radial clearance and they are to be sharpended by grinding the faces the same as in any formed cutter. Saws are made to order and of any size required.

Prices quoted upon application.

Saws of special sizes can be furnished promptly, when so desired.

In ordering special saws, state for what purpose they are required.

Thin milling cutters are accurately made for use on metal. Clearance is geared by grinding saws concave in the sides, leaving the cutting edge thicker than any other part of the saw.

UNION SCREW SLOTTING CUTTERS

1919 REVISION

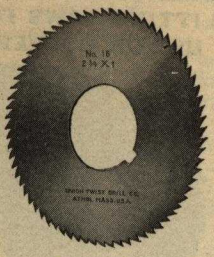


Fig. 14983A

These cutters have a fine pitch of teeth especially adapted for the slotting of screw heads and similar work. They are made from stock rolled carefully to size and are found desirable for many purposes, other than slotting screw heads.

They are not ground on the sides, but will run freely when not used deeper than the bottom of tooth. The thinner saws of this kind are also used by jewelers for sawing chain links, etc. Where used in a slot or running cut, it is often of advantage to run the saw rapidly and feed travel in the same direction, but they are not recommended for deep cuts.

In ordering, always state diameter, number or thickness of cutter and size of hole.

No.	Diam. of Screw Head to be Slotted Inches	Thickness of Cutter by Amer. Stand. Wire Gauge	Diam. of Cutter Inches	Hole in Cutter Inches	Price Each Carbon Steel
P 1	1 5/16	5	2 3/4	1	.90
P 2	1 1/8	6	2 3/4	1	.75
P 3	1	7	2 3/4	1	.65
P 4	7/8	8	2 3/4	3/4 & 1	.55
P 5	3/4, 13/16	9	2 3/4	3/4 & 1	.50
P 6	5/8	10	2 3/4	3/4 & 1	.45
P 7	5/8	11	2 3/4	3/4 & 1	.40
P 8	1/2, 9/16	12	2 3/4	3/4 & 1	.35
P 9	1/2, 9/16	13	2 3/4	3/4 & 1	.30
P10	3/8, 7/16	14	2 3/4	1/2, 5/8, 3/4 & 1	.30
P11	11/32	15	2 3/4	1/2, 5/8, 3/4 & 1	.20
P12	5/16	16	2 3/4	1/2, 5/8, 3/4 & 1	.20
P13	9/32	17	2 3/4	1/2, 5/8, 3/4 & 1	.20
P14	1/4, 9/32	18	2 3/4	1/2, 5/8, 3/4 & 1	.20
P15	3/16, 7/32	19	2 3/4	1/2, 5/8, 3/4 & 1	.20
P16	3/16, 7/32	20	2 3/4	1/2, 5/8, 3/4 & 1	.20
P17	1/8	21	2 3/4	1/2, 5/8, 3/4 & 1	.20
P18	1/8	22	2 3/4	1/2 5/8, 3/4 & 1	.20
P19	1/8	23	2 3/4	1/2, 5/8, 3/4 & 1	.20
P20	1/8	24	2 3/4	1/2, 5/8, 3/4 & 1	.20
P21	1/8	25	2 3/4	1/2, 5/8, 3/4 & 1	.20
P22	1/8	26	2 3/4	3/4 & 1	.20
P23	1/8	27	2 3/4	3/4 & 1	.20
P24	1/8	28	2 3/4	3/4 & 1	.20
P25	1/8	30	2 3/4	3/4 & 1	.20
P26	1/8	32	2 3/4	3/4 & 1	.20
P27	1/8	34	2 3/4	3/4 & 1	.20
P28	1/8	10	2 1/4	5/8	.40
P29	1/8	11	2 1/4	5/8	.35
P30	1/8	12	2 1/4	5/8	.30
P31	1/8	13	2 1/4	5/8	.20
P32	1/8	14	2 1/4	5/8	.20
P33	1/8	15	2 1/4	5/8	.20
P34	1/8	16	2 1/4	5/8	.20
P35	1/8	17	2 1/4	5/8	.20
P36	1/8	18	2 1/4	5/8	.20
P37	1/8	19	2 1/4	5/8	.20
P38	3/16	20	2 1/4	5/8	.20
P39	1/8	21	2 1/4	5/8	.20
P40	1/8	22	2 1/4	5/8	.20
P41	1/8	23	2 1/4	5/8	.20
P42	1/8	24	2 1/4	5/8	.20
P43	1/8	25	2 1/4	5/8	.20
P44	1/8	26	2 1/4	5/8	.20
P45	1/8	27	2 1/4	5/8	.20
P46	1/8	28	2 1/4	5/8	.20
P47	1/8	30	2 1/4	5/8	.20
P48	1/8	32	2 1/4	5/8	.20
P49	1/8	34	2 1/4	5/8	.20
P50	3/8	14	1 3/4	5/8	.20
P51	11/32	15	1 3/4	5/8	.20
P52	5/16	16	1 3/4	5/8	.20
P53	9/32	17	1 3/4	5/8	.20
P54	1/4	18	1 3/4	5/8	.20
P55	7/32	19	1 3/4	5/8	.20
P56	3/16	20	1 3/4	5/8	.20
P57	1/8	21	1 3/4	5/8	.20
P58	1/8	22	1 3/4	5/8	.20
P59	1/8	23	1 3/4	5/8	.20
P60	1/8	24	1 3/4	1/2	.15
P61	1/8	25	1 3/4	1/2	.15
P62	1/8	26	1 3/4	1/2	.15
P63	1/8	27	1 3/4	1/2	.15
P64	1/8	28	1 3/4	1/2	.15
P65	1/8	30	1 3/4	1/2	.15
P66	1/8	32	1 3/4	1/2	.15
P67	1/8	34	1 3/4	1/2	.15

Screw slotters of high speed steel can be furnished. Prices upon application.